

**CORRECTIVE MEASURES STUDY WORK PLAN
FOR
SWMUs 2, 3, 5, 7, 17, AND 33 AND AOC 8
AK STEEL KANSAS CITY FACILITY**

Permit MOD007118029

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**Prepared By
Burns & McDonnell Engineering Company, Inc.
Engineers - Architects - Consultants
Kansas City, Missouri**

512739



RCRA

CORRECTION MEASURES STUDY WORK PLAN
FOR
SWMUS 2, 3, 5, 7, 17, AND 33 AND AOC 8
AK STEEL
7000 WINNER ROAD, KANSAS CITY, MO
PROJECT NUMBER 29259

INDEX AND CERTIFICATION PAGE

<u>DOCUMENT / DIVISION</u>	<u>DESCRIPTION</u>	<u>NUMBER OF PAGES</u>
2.4	ADDITIONAL DATA NEEDS	2
Table 2-3	SWMU 3 – South of Bar Fab Landfill, Groundwater Samples	
Table 2-4	SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank, Subsurface Soil Samples	
Table 2-5	SWMU 17 – Wire Mill Rinsewater Neutralization Tanks and SWMU 33 – Nail Mill Degreasing Area, Groundwater Samples	
Table 2-6	AOC 8 – “Owl Gun Club” Shooting Park, Subsurface Soil Samples	
Figure 2-1	SWMU 3 – Groundwater Sampling Locations	
Figure 2-2	SWMU 7 – Soil Sampling Locations	
Figure 2-3	SWMUs 17 & 33 – Groundwater Sampling Locations	
Figure 2-4	AOC 8 – Soil Sampling Locations	

CERTIFICATION



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TABLE OF CONTENTS

	<u>Page No.</u>
LIST OF TABLES	TC-3
LIST OF FIGURES	TC-3
LIST OF ACRONYMS AND ABBREVIATIONS	TC-4
1.0 INTRODUCTION AND BACKGROUND INFORMATION	1-1
1.1 Purpose and Scope	1-1
1.2 Report Organization	1-1
1.3 Background Information	1-3
1.3.1 Facility Location	1-3
1.3.2 Tasks Completed to Date	1-3
1.3.2.1 Interim Measures Tasks	1-3
1.3.2.2 RFI Tasks	1-4
1.3.3 SWMU/AOC Background Information	1-5
1.3.3.1 SWMU 2 – Old Blue River “W” Landfill	1-5
1.3.3.2 SWMU 3 – South of Bar Fab Landfill	1-6
1.3.3.3 SWMU 5 – Plant Rubble Landfill	1-7
1.3.3.4 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tanks	1-8
1.3.3.5 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area	1-9
1.3.3.6 AOC 8 – “Owl Gun Club” Shooting Park	1-12
2.0 CORRECTIVE MEASURES OBJECTIVES	2-1
2.1 Corrective Measures Objectives	2-1
2.2 Compliance Points	2-1
2.3 Development of Remedial Action Goals	2-2
2.3.1 Soil Protection Standards	2-3
2.3.2 Groundwater Protection Standards	2-4
2.4 Additional Data Needs	2-6
2.4.1 SWMU 3 – South of Bar Fab Landfill	2-6
2.4.2 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tanks	2-6
2.4.3 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area	2-7
2.4.4 AOC 8 – “Owl Gun Club” Shooting Park	2-7
3.0 CORRECTIVE MEASURES ALTERNATIVES	3-1
3.1 Identification of Potentially Applicable Technologies	3-1
3.1.1 “No Action” Technologies	3-2
3.1.1.1 Monitoring Programs	3-2
3.1.1.2 Access Control	3-2
3.1.1.3 Land and Groundwater Use Restrictions	3-2

3.1.2	Source Control Technologies.....	3-3
3.1.2.1	Constructed Barriers	3-3
3.1.2.2	Caps	3-3
3.1.2.3	Surface Contouring	3-3
3.1.3	Ex-Situ Soil Treatment Technologies.....	3-3
3.1.3.1	Biological Treatment	3-3
3.1.3.2	Thermal Treatment	3-3
3.1.3.3	Solidification/Stabilization	3-4
3.1.3.4	Off-Site Landfilling	3-4
3.1.3.5	Soil Washing and Acid Extraction	3-4
3.1.4	In-Situ Soil Treatment Technologies	3-4
3.1.4.1	Electrokinetic Separation.....	3-4
3.1.4.2	Soil Vapor Extraction	3-5
3.1.4.3	Solidification/Stabilization	3-5
3.1.4.4	Enhanced Soil Vapor Extraction	3-5
3.1.4.5	Chemical Oxidation-Reduction	3-6
3.1.5	Groundwater Treatment Technologies	3-6
3.1.5.1	Groundwater Recovery Wells.....	3-6
3.1.5.2	Natural Attenuation	3-6
3.1.5.3	Chemical Oxidation-Reduction	3-6
3.1.5.4	Air Sparging.....	3-7
3.1.5.5	Hydrofracturing	3-7
3.1.5.6	Passive/Reactive Treatment Walls	3-8
3.1.5.7	Fluid Vapor Extraction	3-8
3.2	SWMU/AOC Remedial Alternative Evaluation.....	3-9
3.2.1	SWMUs 2, 3, and 5 - Landfills	3-9
3.2.2	SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank.....	3-9
3.2.3	AOC 8 – “Owl Gun Club” Shooting Park	3-9
3.2.4	SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area	3-10
4.0	EVALUATION OF CORRECTIVE MEASURES	4-1
4.1	Technique for Evaluation of Corrective Measure Alternatives	4-1
4.2	Decision Making Process for Corrective Measure Alternatives.....	4-2
4.2.1	Protection of Human Health and the Environment.....	4-3
4.2.2	Attainment of Media Cleanup Standards.....	4-3
4.2.3	Control Source of Release	4-4
4.2.4	Compliance with Applicable Standards for Waste Management	4-4
4.2.5	Long-Term Reliability and Effectiveness	4-5
4.2.6	Reduction of Toxicity, Mobility, or Volume	4-5
4.2.7	Short-Term Effectiveness	4-6
4.2.8	Implementability	4-7
4.2.9	Economic Feasibility	4-7
5.0	PILOT, LABORATORY, and/or BENCH SCALE STUDIES	5-1
6.0	CMS REPORT OUTLINE	6-1

Table of Contents

7.0	PROJECT MANAGEMENT	7-1
7.1	Organization.....	7-1
7.1.1	Burns & McDonnell.....	7-1
7.1.2	Contractors.....	7-2
7.2	Project Schedule	7-3
8.0	REFERENCES	8-1

APPENDICES

Appendix A - Calculation of Corrective Action Objectives

LIST OF TABLES

Table No.	Title
2-1	Potential Protection Standards for Soil
2-2	Potential Protection Standards for Groundwater
2-3	SWMU 3 – South of Bar Fab Landfill, Groundwater Samples
2-4	SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank, Subsurface Soil Samples
2-5	SWMU 17 – Wire Mill Rinsewater Neutralization Tank and SWMU 33 – Nail Mill Degreasing Area, Groundwater Samples
2-6	AOC 8 – “Owl Gun Club” Shooting Park, Subsurface Soil Samples
3-1	Identification of Potentially Applicable “No Action” Technologies
3-2	Identification of Potentially Applicable Source Control Technologies
3-3	Identification of Potentially Applicable Ex-Situ Soil Treatment Technologies
3-4	Identification of Potentially Applicable In-Situ Soil Treatment Technologies
3-5	Identification of Potentially Applicable Groundwater Treatment Technologies

LIST OF FIGURES

Figure No.	Title
1-1	Site Location Map
1-2	Facility Map
1-3	SWMU 2 – Old Blue River “W” Landfill
1-4	SWMU 3 – South of Bar Fab Landfill
1-5	SWMU 5 – Plant Rubble Landfill
1-6	SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank
1-7	SWMUs 17 & 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area
1-8	AOC 8 – “Owl Gun Club” Shooting Park
2-1	SWMU 3 – Groundwater Sampling Locations
2-2	SWMU 7 – Soil Sampling Locations
2-3	SWMUs 17 & 33 – Groundwater Sampling Locations
2-4	AOC 8 – Soil Sampling Locations
7-1	Organization Chart
7-2	Project Schedule

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
bgs	below ground surface
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
BMWCI	Burns & McDonnell Waste Consultants, Inc.
CALM	Cleanup Levels for Missouri
CAO	Corrective Action Objective
CCC	Contaminant Continuous Concentration
cis-1,2-DCE	cis-1,2-Dichloroethene
CMC	Contaminant Maximum Concentration
CMS	Corrective Measures Study
COPC	Chemical of Potential Concern
DAF	Dilution Attenuation Factor
ERA	Ecological Risk Assessment
ES	Electrokinetic Separation
GC	Gas Chromatograph
GST	GST Steel Company
GTARC	Groundwater Target Concentration
HHRA	Human Health Risk Assessment
HSWA	Hazardous and Solid Waste Amendments
HVDP	High Vacuum Dual Phase Extraction
IM	Interim Measures
J*	Value was qualified as estimated during the QA/QC data review.
KCT	Kansas City Terminal Railway Company
MCL	Maximum Contaminant Level
MDNR	Missouri Department of Natural Resources
Permit	AK Steel's Part B Post-Closure Permit
PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFI Report	RCRA Facility Investigation Report, Armco Kansas City Facility
RFI Workplan	RCRA Facility Investigation Workplan, Armco Kansas City Facility

LIST OF ACRONYMS AND ABBREVIATIONS

SDWA	Safe Drinking Water Act
SSL	Soil Screening Level
STARC	Soil Target Concentration
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound
XRF	X-ray Fluorescence Spectroscopy

* * * * *

1.0 INTRODUCTION AND BACKGROUND INFORMATION

AK Steel (formerly Armco Inc.¹) has conducted a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) at its former Kansas City, Missouri Works. Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared this Corrective Measures Study (CMS) Work Plan on behalf of AK Steel to satisfy the "Special Permit Conditions" presented in Part II of AK Steel's Part B Post-Closure Permit (Permit). The final Hazardous and Solid Waste Amendments (HSWA) Part II Permit was issued by the United States Environmental Protection Agency (USEPA) Region VII on November 30, 1994 (EPA ID# MOD 007118029).

1.1 PURPOSE AND SCOPE

In accordance with Section XXXII of the Permit and in response to USEPA's October 30, 2001 "Notice to Conduct a Corrective Measures Study," AK Steel is submitting this CMS Work Plan for Solid Waste Management Units (SWMUs) 2, 3, 5, 7, 17, and 33 and Area of Concern (AOC) 8. This document describes the general approach for investigating/evaluating potential remedies and defining corrective action objectives. It also describes remedies preliminarily identified for evaluation during the CMS. As defined in the "Notice to Conduct a Corrective Measures Study," the scope of this report includes the following SWMUs and AOC:

- SWMU 2 – Old Blue River "W" Landfill
- SWMU 3 – South of Bar Fab Landfill
- SWMU 5 – Plant Rubble Landfill
- SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank
- SWMUs 17 & 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area
- AOC 8 – "Owl Gun Club" Shooting Park

1.2 REPORT ORGANIZATION

This document consists of one volume. Tables and figures are found at the end of the section in which they are referenced. The document is organized as follows:

¹ Effective September 30, 1999, Armco Inc. was merged with and into AK Steel Corporation, a Delaware Corporation with headquarters in Middletown, Ohio.

- Section 1.0 – Introduction and Background Information
- Section 2.0 – Corrective Measures Objectives
- Section 3.0 – Corrective Measures Alternatives
- Section 4.0 – Evaluation of Corrective Measures
- Section 5.0 – Pilot, Laboratory and/or Bench Scale Studies
- Section 6.0 – CMS Report Outline
- Section 7.0 – Project Management
- Section 8.0 – References
- Appendix A – Calculation of Corrective Action Objectives

Additional documents have been prepared during the course of the corrective action process at the AK Steel Facility. These documents provide useful background information regarding the SWMUs and AOC discussed in this Work Plan and provide more detailed information regarding previous investigation activities:

- *Annual Groundwater Monitoring Reports, Kansas City Facility Emission Control Dust Landfill* (Burns & McDonnell, 1982-1997).
- *Part B Post-Closure Permit Application for the Emission Control Dust Landfill at Armco, Inc.* (Burns & McDonnell, 1987).
- *RCRA Facility Investigation Workplan, Armco Kansas City Facility* (RFI Workplan) (BMWCI, 1996)
- *Addendum No. 1 to the RCRA Facility Investigation Workplan, Armco Kansas City Facility* (BMWCI, 1997a).
- *Addendum No. 2 to the RCRA Facility Investigation Workplan, Armco Kansas City Facility* (BMWCI, 1997b).
- *Addendum No. 3 to the RCRA Facility Investigation Workplan, Armco Kansas City Facility* (BMWCI, 1997c).
- *Phase 1 Data Package, RCRA Facility Investigation, Armco Kansas City Facility* (BMWCI, 1997d).
- *RCRA Facility Investigation Report, Armco Kansas City Facility* (RFI Report) (BMWCI, 1999).
- *Quality Assurance Project Plan for Groundwater Sampling at the Nail Mill Degreasing Area, AK Steel Kansas City Facility* (Burns & McDonnell, 2000).

1.3 BACKGROUND INFORMATION

1.3.1 Facility Location

Figure 1-1 presents a Site location map. The Facility is located in northeast Kansas City, Missouri within the Blue River and Missouri River flood plains. Portions of the Facility are located both east and west of Interstate Highway 435 (I-435). Industrial activities were performed exclusively in the area west of I-435, north of 12th Street, and east of Ewing Avenue.

The Facility is located on property owned by AK Steel and GS Technologies Operating Company, Inc. (doing business as GST Steel Company) (GST), and totals approximately 860 acres. As used in this document, the term "Facility" is defined by RCRA permitted property owned by AK Steel (approximately 560 acres) as well as SWMUs and AOCs located on GST property (approximately 300 acres). Figure 1-2 is a Facility location map that displays the SWMUs and AOCs. This figure also shows AK Steel and GST owned property boundaries and leased properties. The SWMUs and AOC described in this Work Plan are all located on AK Steel property.

Although certain property and operations were transferred to GST in November 1993, AK Steel retained ownership of approximately 560 acres of the Facility. Approximately 100 acres of the property retained by AK Steel were leased by GST, and GST had operating facilities on this property until they ceased operations and filed for bankruptcy in April 2001. In October 1998, a portion of the property, totaling less than one (1) acre, was sold to Kansas City Terminal Railway Company (KCT) for the construction of an overhead Railroad Bridge known as the Flyover Project. A portion of the property was also provided for unlimited project site access and use by KCT under a 2-year easement agreement during construction of the Flyover Project.

1.3.2 Tasks Completed to Date

1.3.2.1 Interim Measures Tasks

Interim Measures (IM) tasks were detailed in the RFI Report. These tasks were primarily concerned with activities conducted at SWMUs 10, 12, 24, 25, and 26 and do not need further discussion for the purposes of this CMS Work Plan.

In September 2000, EPA submitted a Notification for Interim Measures at SWMUs 17 and 33 (i.e., SWMU 33 area). This notification sought to impose quarterly groundwater monitoring in the SWMU 33 area. By letter from Mr. Paul W. Casper, Jr. of Frost Brown Todd LLC, AK Steel invoked the dispute

resolution provision of its Permit (Section XXIV) regarding this notification in October 2000. As part of the January 2001 Agreement to Resolve Dispute, AK Steel prepared a Quality Assurance Project Plan and conducted a groundwater sampling event in the SWMU 33 area. Results of this groundwater sampling event were provided in the First Quarter 2001 Quarterly Progress Report mandated by Section XIX of the Permit.

1.3.2.2 RFI Tasks

In September 1995, USEPA and the Missouri Department of Natural Resources (MDNR) requested submittal of an RFI Workplan. The *RCRA Facility Investigation Workplan for the Armco Kansas City Facility* (RFI Workplan) was submitted on March 14, 1996 (BMWCI, 1996). USEPA and MDNR granted approval of the RFI Workplan in November 1996 contingent upon the preparation of an addendum to address comments. *Addendum No. 1 to the RFI Workplan* was submitted on February 3, 1997 (BMWCI, 1997a).

Field activities outlined in the RFI Workplan commenced in March 1997. Phase 1 RFI field activities involved the collection of approximately 57 surface soil samples, 195 subsurface soil samples, and 84 groundwater samples from 15 SWMUs and three AOCs. The *Phase 1 Data Package, RCRA Facility Investigation*, submitted on December 1, 1997, summarized the results of this investigation (BMWCI, 1997d).

Based upon the results of the Phase 1 investigation, additional work was planned to further delineate the nature and extent of contamination at the Facility. *Addendum No. 3 to the RFI Workplan*, also submitted on December 1, 1997, outlined additional investigation activities (BMWCI, 1997c). Following the March 1998 approval of Addendum No. 3 by USEPA and MDNR, RFI Phase 2 field activities were conducted from April through September 1998. Phase 2 activities involved the collection of approximately 35 surface soil, 110 trench soil, 125 test pit soil, 300 direct-push soil, 4 sediment, 4 surface water, and 67 groundwater samples from 11 SWMUs and two AOCs.

The *RCRA Facility Investigation Report* was submitted to USEPA and MDNR on September 14, 1999 (BMWCI, 1999). The RFI Report detailed the results of the IM to date and the RFI sampling activities.

1.3.3 SWMU/AOC Background Information

A summary of background information for SWMUs 2, 3, 5, 7, 17, and 33 and AOC 8 is provided in the following sections. Detailed background information and more extensive information regarding investigation findings are located in the RFI Report (BMWCI, 1999).

1.3.3.1 SWMU 2 – Old Blue River “W” Landfill

SWMU Background

The Old Blue River “W” Landfill (SWMU 2), located on AK Steel property (see Figure 1-2), is a closed landfill previously utilized to manage emission control dust and solid waste. W-shaped portion of the Old Blue River channel was used to dispose of emission control dust generated in the No. 1 and No. 2 Melt Shop electric arc furnaces. In addition, general plant and office trash was disposed in this SWMU. SWMU 2 covers an area of approximately 15-acres and is estimated to contain approximately 185,000 cubic yards of material.

The landfill was closed through construction of a soil cap (approximately three feet of compacted soil) and a vegetative (fescue grass) cover. The soil cover and vegetative stand remain in good condition. This site has been classified as a Class III Site on the Missouri Registry of Confirmed Abandoned or Uncontrolled Sites. Class III is defined as “does not present a significant threat to public health or the environment – action may be deferred.”

Nature and Extent of Contamination

Figure 1-3 depicts SWMU 2 and the RFI sampling locations. Groundwater samples were collected around SWMU 2 and analyzed for dissolved cadmium and lead, volatile organic compounds (VOCs), and/or semivolatile organic compounds (SVOCs). On-site field gas chromatography (GC) was also used for VOC analysis of groundwater samples collected from borings 02B04A and 02B10 through 02B17.

Dissolved cadmium was not detected at any of its sampling locations. Dissolved lead was detected in 11 of 18 groundwater samples. Lead detections in seven of the groundwater samples exceeded the Safe Drinking Water Act (SDWA) Maximum Contaminant Level (MCL) of 0.015 mg/L that was used for nature and extent screening during the RFI. Four of the seven samples with concentrations above the MCL were collected from perched groundwater, and dissolved lead concentrations in the saturated zone ranged up to 0.069 mg/L.

VOCs were detected in five out of nine groundwater samples, but only three samples had one or more VOC detections that exceeded screening levels. One detection each of benzene (5.79 $\mu\text{g/L}$), ethylbenzene (4,140 D $\mu\text{g/L}$), total xylenes (22,100 $\mu\text{g/L}$), and methylene chloride (33.7 $\mu\text{g/L}$) exceeded groundwater screening MCLs (5,700, 10,000, and 5 $\mu\text{g/L}$, respectively). All VOC exceedences occurred in perched groundwater samples, and samples from the saturated zone were either non-detect for VOCs or contained VOC detections at concentrations below groundwater screening MCLs. SVOC analysis was performed on one groundwater sample and only one detection each of 2,4-dimethylphenol and isophrone occurred (no MCLs exist for these compounds).

Potential migration pathways at SWMU 2 include soil transfer to groundwater, groundwater transport, and volatilization to the air. The potential for both soil transfer to groundwater and volatilization to air is limited due to the soil cap and vegetative cover constructed over the landfill that limits infiltration of storm water through the landfill and contact with landfill contents. Based on the data, soil transfer to groundwater may have occurred prior to capping due to the presence of VOCs and dissolved lead in the groundwater at SWMU 2. This SWMU is located approximately 600 to 700 feet south of the Blue River, and groundwater is expected to flow in a north-northeast direction toward the Blue River. VOCs are expected to degrade as they migrate in the direction of groundwater flow. However, VOCs were primarily detected in groundwater samples collected from the perched groundwater, and VOCs were either not-detected or detected in concentrations below MCLs in groundwater samples collected from the saturated zone. Dissolved lead in groundwater is not expected to migrate significantly in groundwater given its strong soil adsorption properties. Several of the higher concentrations of dissolved lead (above the MCL) were also from samples collected from perched groundwater.

1.3.3.2 SWMU 3 – South of Bar Fab Landfill

SWMU Background

The South of Bar Fab Landfill (SWMU 3) is located partially on AK Steel property (see Figure 1-2) and partially on property owned by the City of Kansas City, Missouri. SWMU 3 is a closed landfill previously utilized to manage emission control dust and various solid waste materials. SWMU 3, which covers an area of just over 1-acre, was closed in 1980 through construction of a soil cap (approximately three feet of compacted soil) and a vegetative cover (fescue grass). A portion of the area in the general vicinity of the SWMU, including a portion of the landfill itself, was deeded to the City in 1983 for

completion of channelization work on the adjacent Blue River. The cap was subsequently upgraded on the western portion of the landfill to a concrete cover, which was also extended across a drainage culvert located along the northern edge of the landfill. In the spring of 1998, modifications were made in the SWMU 3 area when a paved access road was constructed over the top of the closed landfill. The landfill was found to encompass approximately 44,000 square feet and with a maximum thickness of 17 feet. Total volume of the landfill was estimated to be approximately 14,000 cubic yards (Remcor, 1988).

Nature and Extent of Contamination

Figure 1-4 depicts SWMU 3 and the RFI sampling locations. Groundwater samples were collected around the SWMU for dissolved cadmium and lead analyses. Dissolved cadmium was not detected. Dissolved lead was detected in four of the six samples, and all detections were below the groundwater screening MCL (0.015 mg/L).

Potential migration pathways at SWMU 3 include soil transfer to groundwater and groundwater transport. The potential for soil transfer to groundwater is limited due to the asphalt and soil cap with vegetative cover constructed over the landfill. Based on the groundwater data collected at SWMU 3, it does not appear that soil transfer to groundwater has occurred. Therefore, contaminant migration via soil transfer to groundwater and groundwater transport is not expected.

1.3.3.3 SMWU 5 – Plant Rubble Landfill

SWMU Background

The Plant Rubble Landfill (SWMU 5), located on AK Steel property (see Figure 1-2), is a landfill which was utilized by Armco from 1980 to 1993 to manage rubble and demolition materials. The landfill was capped and subsequently vegetated (fescue grass). The vast majority of the landfill contents were concrete, sand, earth, rock, etc. SWMU 5 covers an approximate area of less than 3 acres. The volume of materials contained in the landfill is estimated at 120,000 cubic yards.

Nature and Extent of Contamination

Figure 1-5 depicts SWMU 5 and the RFI sampling locations. Groundwater samples were collected around the west, south, and east sides of the SWMU for dissolved cadmium and lead analyses. No detections of dissolved cadmium or lead occurred in the six groundwater samples. Direct-push groundwater samples could not be collected on the north side of the SWMU due to the adjacent RCRA

Landfill. However, groundwater data collected from 1988 through 1997 from monitoring wells located on the north side of this landfill has not shown the presence of dissolved cadmium or lead (i.e., Results were typically non-detect or had limited detections below MCLs.).

Potential migration pathways at SWMU 5 include soil transfer to groundwater and groundwater transport. The potential for soil transfer to groundwater and storm water runoff contacting landfill contents is limited due to the soil cap and vegetative cover constructed over the landfill. Based on the groundwater data collected at SWMU 5 and historical data from the adjacent RCRA Landfill, contaminant migration via soil transfer to groundwater and groundwater transport is not expected for SWMU 5.

1.3.3.4 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tanks

SWMU Background

The No. 1 Melt Shop Baghouse Dust Tanks (SWMU 7), located on AK Steel property (see Figure 1-2), consisted of two former tanks utilized for temporary storage of emission control dust. The total storage capacity of the tanks was approximately 75 cubic yards. Prior to their demolition in 1991, the tanks were cleaned by a remediation contractor, and emission control dust was removed from dust handling equipment. No evidence of SWMU 7 remains. The original defined SWMU area was approximately 50 feet by 25 feet (less than 0.05 acres) in size. During the RFI, the SWMU 7 area expanded in size west and south of the former tanks to approximately 2 acres.

Nature and Extent of Contamination

Figure 1-6 depicts SWMU 7 and the RFI sampling locations. A total of 198 surface soil and subsurface soil samples were collected for cadmium and lead analyses, and 6 subsurface soil samples were analyzed for soil pH. X-ray fluorescence (XRF) spectroscopy was used to field screen for lead in samples from Borings 07B09 to 07B35.

Soil pH values were basic (pH 9.1 J* to 11.5 J*). Cadmium and lead were detected throughout the sampling area (highest concentrations 281 DJ* and 14,300 J* mg/Kg, respectively) at concentrations exceeding the Soil Screening Levels (SSLs, 8 mg/Kg for cadmium and 400 mg/Kg for lead) that were used for nature and extent screening during the RFI. In many locations, samples were collected until physical restrictions were reached (i.e. No. 1 Melt Shop foundation to the north and Blue River to the

south). The horizontal extent of cadmium and lead was defined by Boring 07B23 to the east of SWMU 7. Along the north, south, and west, the horizontal extent was defined by either sampling locations (Test Pits 07TP01 through 07TP06 to the west) or physical restrictions (No. 1 Melt Shop on the north and the Blue River on the south). The majority of the cadmium and lead contamination was limited to the upper 4 feet of soil.

Potential migration pathways at SWMU 7 include soil transfer to groundwater, groundwater transport, storm water runoff, surface water transport, and airborne dust migration. Soil detections of cadmium and lead exceeded SSLs (based on soil migration to groundwater) thus indicating that soil transfer to groundwater could occur. The tendency for metals to strongly adsorb to soil and the basic pH of the soil at SWMU 7 are expected to limit vertical migration of metals in soil. Groundwater was not encountered during subsurface soil sampling and groundwater samples were not collected. Groundwater transport is not expected to be a significant migration pathway for SWMU 7. Storm water runs directly to the Blue River in the western- and southern-most portions of SWMU 7 or to storm drains/storm sewers in the SWMU area that discharge to the Blue River. Surface soil particulate (dust) could become airborne. The prevailing wind direction at the Facility is from the south-southwest to the north-northeast. Thus, storm water runoff, storm sewer transport, surface water transport, and airborne dust transport are potential routes for contaminant migration at SWMU 7.

1.3.3.5 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area

SWMU Background

The Wire Mill Rinsewater Neutralization Tank (SWMU 17), located on AK Steel property (see Figure 1-2), consisted of an open-topped 18,000-gallon concrete underground storage tank (UST) with an acid-proof brick lining. During its operation, the tank received acid rinse waters from the hydrochloric acid wire cleaning operations and the sulfuric acid rod cleaning operations. The SWMU 17 tank was cleaned and closed in place in 1991 as part of the closure activities at the Wire Mill. The defined SWMU area is approximately 50 feet by 80 feet (less than 0.1 acres). In August 1998, modifications were made in the area as Wilson Avenue was extended in an east-west direction across the west of SWMU 17. As part of this modification, the concrete walls of SWMU 17 were lowered to below ground surface. The concrete from the walls and other imported aggregate materials were used to fill the void left by the former tank.

Introduction

The Nail Mill Degreasing Area (SWMU 33), located on AK Steel property (see Figure 1-2), consisted of a degreaser that was used for the removal of residue during the production of nails. This degreasing area was located in the northwest part of the Nail Mill. The presence of chlorinated VOCs in the surrounding area was discovered and reported in 1991 while preparations were being made for the closure and conversion of the mill into a warehouse. The degreaser had previously been demolished, and a wood floor that contained trichloroethene (TCE) was removed and properly disposed. Subsequent investigations in the area confirmed VOCs in the soils surrounding the former degreaser location and a groundwater plume of VOCs in the area. The area currently consists of slag aggregate over the concrete floor of the former building. The defined SWMU 33 area is approximately 2.5 acres in size. Due to the close proximity of SWMU 17 and the related nature of groundwater contamination in the area, SWMU 17 groundwater information is presented with the SWMU 33 data. The area investigated for SWMU 33 groundwater included the entire area north of the Wire Mill Building to the Blue River, and encompassed SWMUs 13 and 17.

Nature and Extent of Contamination

Figure 1-7 depicts SWMUs 17 and 33, and presents the RFI sampling locations. Subsurface soil and groundwater samples were collected from SWMU 17 and analyzed for pH, RCRA metals, and/or VOCs. Subsurface soil and groundwater samples were collected from SWMU 33 and analyzed for VOCs and SVOCs. Direct-push groundwater samples were collected throughout the SWMU 33 area and analyzed on-site using a field GC as part of the RFI. In addition, groundwater samples were collected from the SWMU 33 area in early 2001.

Soil Nature and Extent of Contamination

The majority of the SWMU 17 soil samples exhibited neutral to slightly basic pH values (7.8 J* to 9.3 J*), and one sample exhibited a basic pH of 11.9 J*. Two soil borings were installed during RFI Phase 2 to determine if a source of VOC groundwater contamination was present in the soil at SWMU 17. VOCs were detected in all three subsurface soil samples analyzed. TCE exceeded its SSL (60 $\mu\text{g/Kg}$) for all three samples, ranging up to 655 $\mu\text{g/Kg}$. Vertical extent of subsurface soil VOCs could not be pursued further using direct-push drilling methods due to the presence of subsurface voids, obstructions, and/or the groundwater table. The horizontal extent of VOCs in soil in the immediate SWMU area could not be defined by additional direct-push borings due to subsurface obstructions. However, it is anticipated that the horizontal extent of VOCs in soils is not widespread outside the area of the former acid tank based on

photoionization detector monitoring and visual observations made during installation of Phase 1 soil borings at the SWMU. Since VOCs (primarily TCE) were detected in these borings, the potential for leaching of VOCs from soil to groundwater exists as a source of VOCs in groundwater. However, the SWMU 17 groundwater contamination is part of a larger plume of VOCs whose source is primarily at SWMU 33.

Fifty-eight subsurface soil samples were collected from 23 borings at SWMU 33 and analyzed for VOCs. Total VOC detections ranged from 2.01 to 24,423 $\mu\text{g/Kg}$. Total VOC concentrations greater than 1,000 $\mu\text{g/Kg}$ (15 samples) were located nearest the former degreaser location in the samples collected from Borings 33B01, 33B02, 33B05, 33B14, 33B15, and 33MW2S. Chlorinated VOCs (1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene, TCE, methylene chloride, and vinyl chloride) were typically detected in this area. This information supports an earlier conclusion that degreasing materials remain sorbed onto soils underlying the degreaser area. Nonchlorinated VOCs (benzene, toluene, ethylbenzene, xylenes (BTEX), 2-hexanone, acetone, and carbon disulfide) were also detected, but these detections were more sporadic across the sampling area. Total VOC concentrations decreased radially outward from the former degreaser location. VOCs were encountered at all depth intervals (up to 20 feet bgs) at sampling locations in the immediate vicinity of the former degreaser, and the vertical extent of VOCs was pursued until the groundwater table was reached. Moving radially outward from the former degreaser, VOCs were generally limited to the soil depths below 8 feet bgs.

Groundwater Nature and Extent of Contamination

Eight direct-push groundwater samples were collected at SWMU 17 and analyzed for pH and RCRA metals. All pH results were neutral (pH 6.6 to 6.9). With the exception of dissolved selenium, all of the RCRA metals were detected in at least one groundwater sample; however, only one dissolved lead result (0.115 mg/L) exceeded the groundwater screening MCL (0.015 mg/L). The horizontal extent of dissolved lead in groundwater is assumed to be a localized occurrence and was defined by sampling locations immediately south and east of the one exceedence and by monitoring wells located to the north and west.

During the RFI, groundwater samples were collected for VOC analysis throughout the SWMU 33 area from direct-push borings (approximately 55 samples) and 23 monitoring wells. Figure 1-7 depicts the monitoring well locations. VOCs were detected in groundwater throughout the SWMU 33 area. The

highest concentrations were typically located around the SWMU 33 former degreasing pit (Monitoring Wells 33MW2S, 33MW2, and 33MW3), and decreased radially outward from this location. TCE, which was most likely a source product, and related degradation products cis-1,2-DCE and vinyl chloride were the primary constituents detected. Total VOC results for samples collected from shallow Well 33MW2S [127,847 micrograms per liter ($\mu\text{g/L}$)], intermediate Well 33MW2 (9,042 $\mu\text{g/L}$), and deep Well 33MW3 (511 $\mu\text{g/L}$) were significantly greater than other VOC samples. Total VOC concentrations in surrounding Monitoring Wells 33MW8S, 33MW7S/7D, and 33MW5S/5I/5D (peripheral to the former degreaser location), were significantly lower or non-detect. The horizontal extent of VOCs in the upper saturated zone was defined by samples collected from the perimeter of the SWMU 33 area. The extent of VOCs in the lower saturated zone was less clearly defined to the north due to chlorinated VOC detections in the sample from Well 33MW10D. The source of VOC detections in deep Well 33MW10D is unknown, and it is unclear if these detections are part of the larger plume of VOC detections centered around the former degreaser or from off-site.

1.3.3.6 AOC 8 – “Owl Gun Club” Shooting Park

AOC Background

AOC 8, located on AK Steel property (see Figure 1-2), was a clay pigeon shooting park known as the “Owl Gun Club” which was located south of the Old Blue River “W” Landfill (SWMU 2) and immediately north of Rock Creek. The specific dates of operation of the Owl Gun Club are unknown. From a review of aerial photos, the AOC first becomes visible in 1955 and is no longer visible in 1974. Prior to utilization of the shooting range, the area was used for agriculture. Stationing posts and two trap buildings are visible on a 1955 aerial photograph. The western trap building is no longer present by 1964. By 1974, all evidence of the shooting range has been removed, and the area was again used for agriculture. Because little information is available about the dates the gun club was active or the amount of activity at the club, it is not possible to estimate how much lead shot might be present. The original defined AOC area was approximately 2.5 acres in size. During the RFI, the AOC 8 area expanded in size, primarily to the north, to approximately 6 acres.

Nature and Extent of Contamination

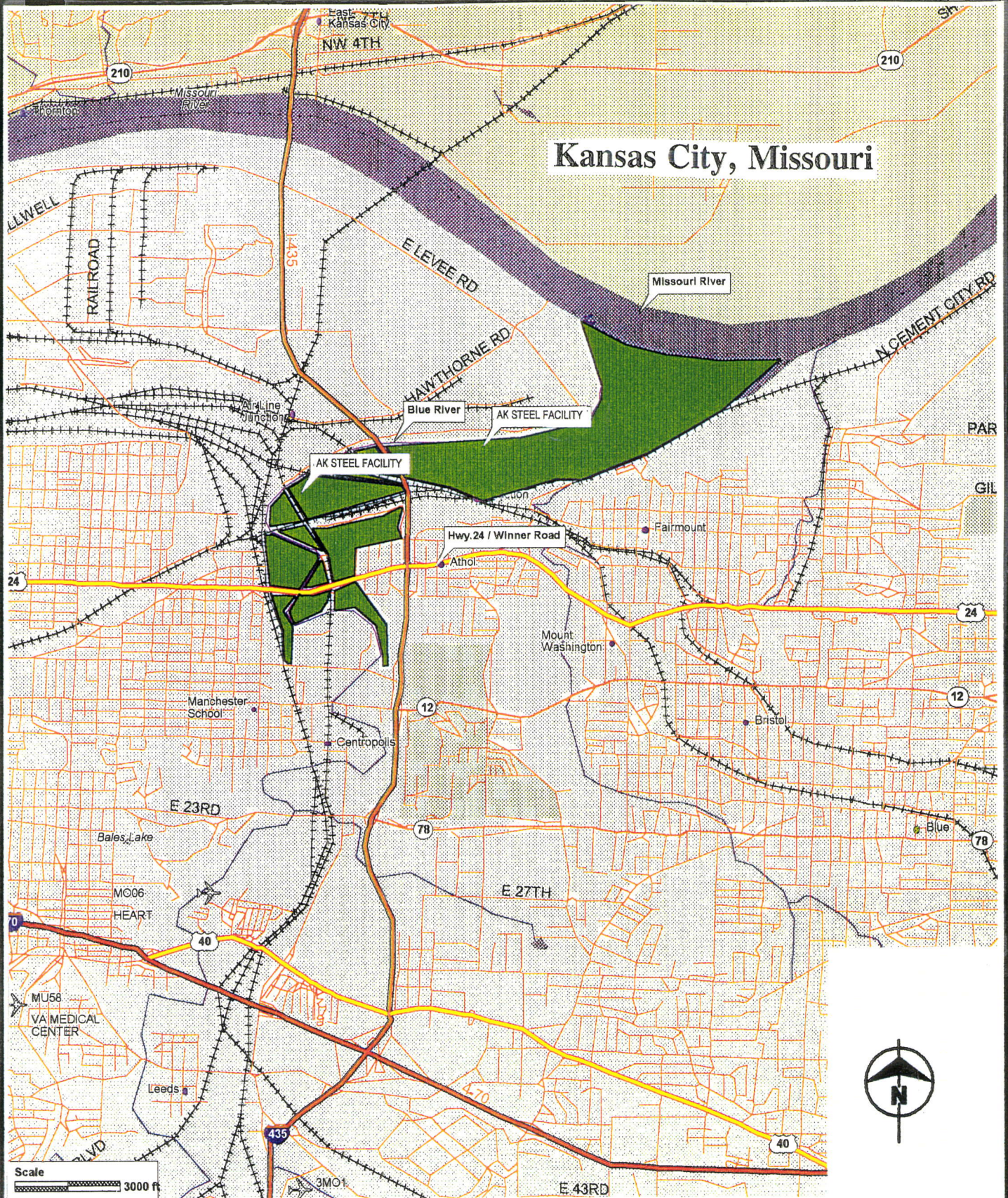
Figure 1-8 depicts AOC 8 and the RFI sampling locations. Ten soil samples were collected for pH, and 122 surface soil and subsurface soil samples were collected for lead analysis. XRF spectroscopy was used to field screen for lead in samples from Borings A08B05 to A08B40.

Soil pH was neutral to slightly basic (pH 7.8 J* to 8.9). The horizontal extent of lead contamination was well defined by borings on the perimeter of the AOC 8 area, but shifted north of the initial AOC definition. In particular, borings around the perimeter of the impacted area generally had lead concentrations less than 100 mg/Kg. Concentrations of lead in soil samples throughout the central portion of the sampling area varied significantly, ranging from concentrations just above the SSL of 400 mg/kg to concentrations as high as 55,200 mg/Kg. The sporadic nature of the data may be attributable to sample homogeneity issues related to the lead shot and the distinct, localized nature of the contamination. That is, some samples may have contained a piece of lead shot, while others samples from the same area may not have contained this material. All but two of the SSL exceedences (and thus the vertical extent of contamination) were limited to the upper two feet of the soil. In the west-central portion of the sampling area, an exception was noted at Boring A08B11 that was located in an area of fill material and contained a lead detection of 11,200 mg/Kg from 4 to 5 feet bgs.

Potential migration pathways at AOC 8 include soil transfer to groundwater, groundwater transport, storm water runoff, and airborne dust migration. Lead was detected throughout AOC 8 at concentrations exceeding SSLs (based on soil migration to groundwater), from the surface to as deep as 5 feet bgs. Therefore, soil transfer to groundwater could occur. The tendency for metals to strongly adsorb to soil and the neutral to slightly basic pH of the soil at AOC 8 are expected to limit vertical migration of metals. Groundwater was not encountered during subsurface soil sampling and groundwater samples were not collected. The saturated zone, as encountered to the north at SWMU 2, is expected to be 5 feet or more below the deepest soil detections above SSLs. Based on the definition of the vertical extent of lead in soil at shallower depths above the saturated zone, and the tendencies for metals to strongly adsorb to soil rather than migrate with groundwater movement, the groundwater transport pathway is not expected to be significant for AOC 8.

Storm water ponds and infiltrates in the immediate AOC area; therefore, storm water runoff should not provide a significant route for contaminant migration. Surface soil particulate (dust) could become airborne. The prevailing wind direction at the Facility is from the south-southwest to the north-northeast. However, based on the size of the lead shot in the soil and the vegetative surface cover, dust migration via the air pathway is not expected to be significant at AOC 8.

* * * * *



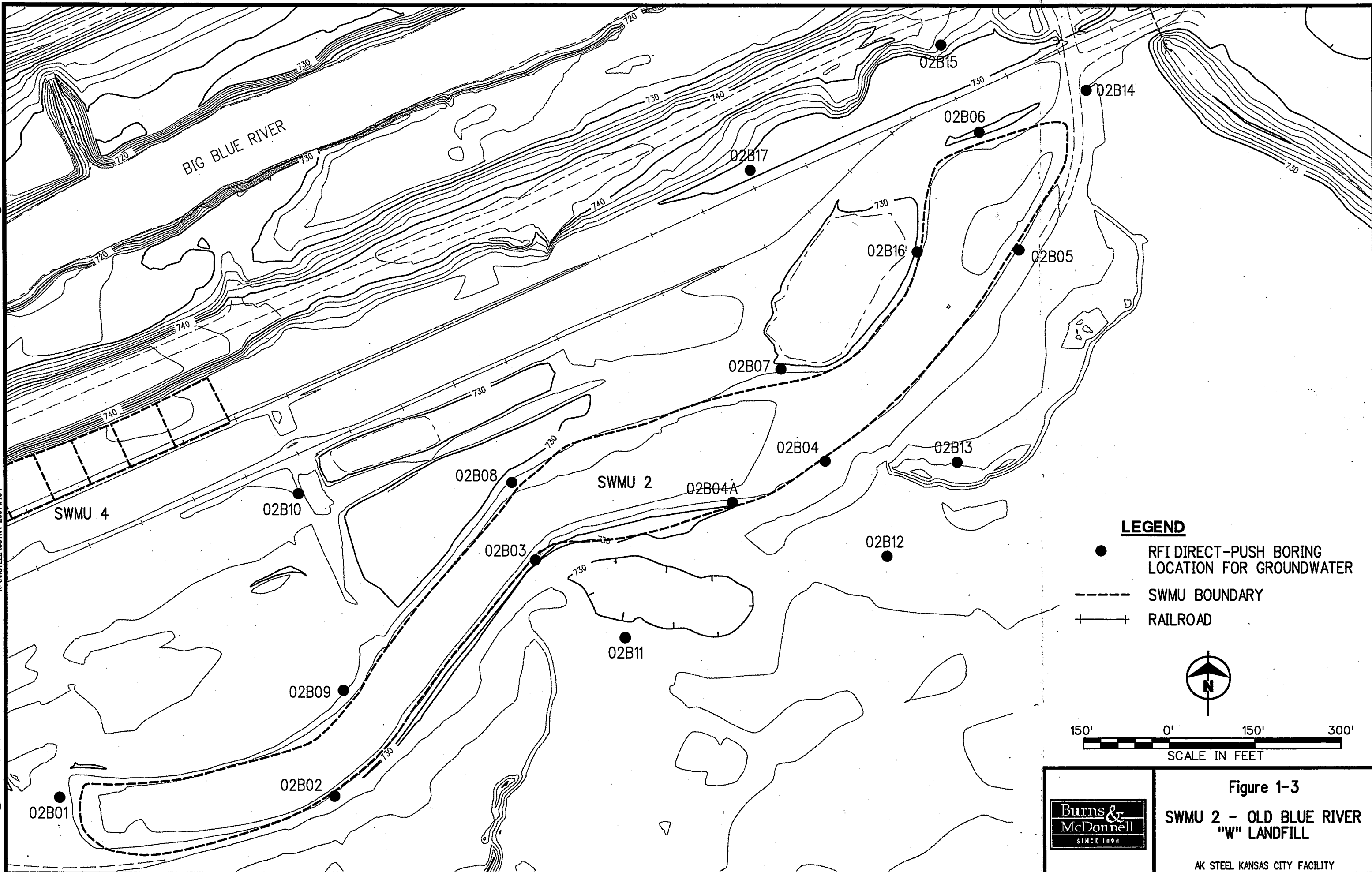
Map created using Precision Mapping 3.0

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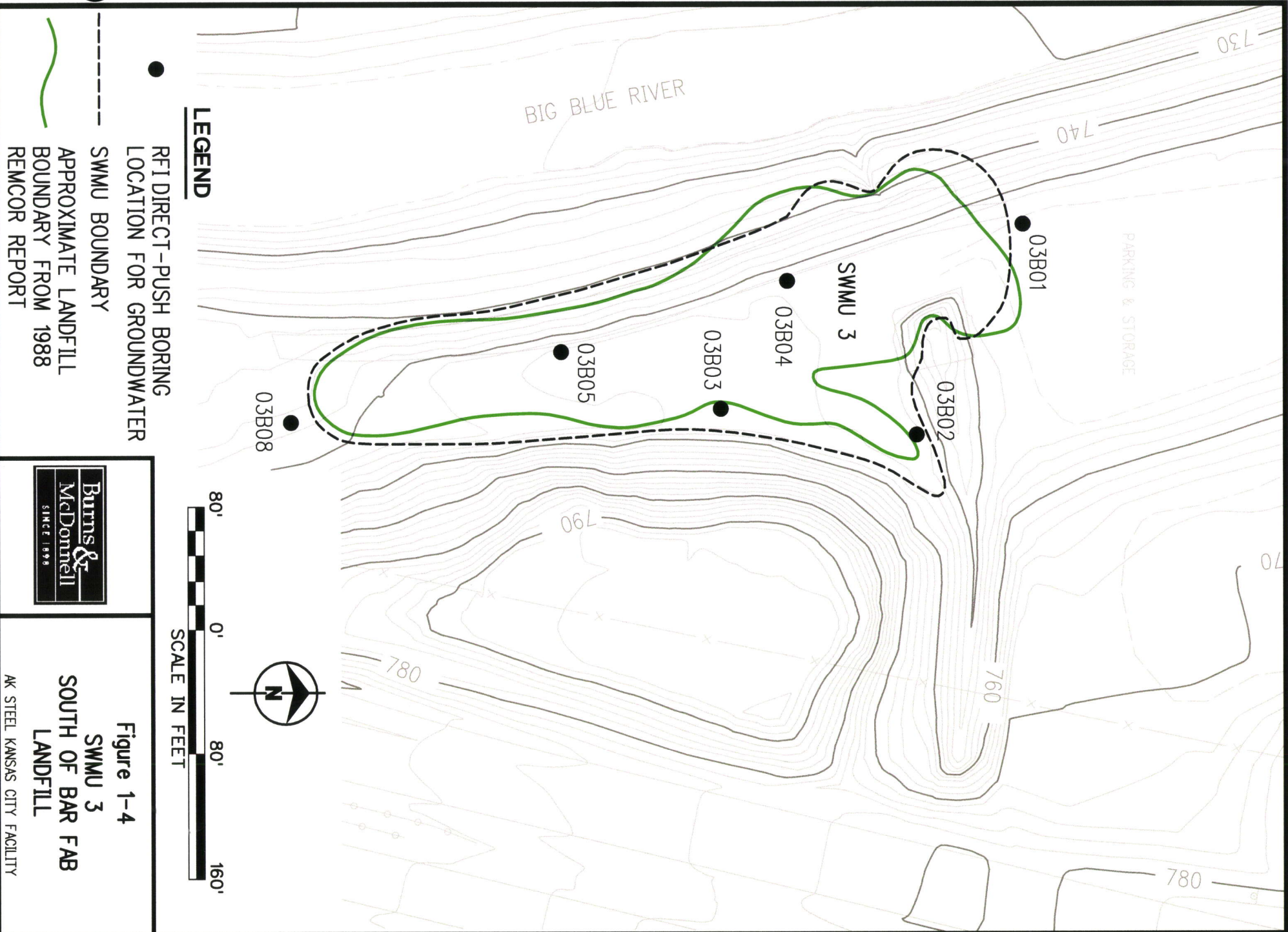
Figure 1-1
SITE LOCATION MAP

AK STEEL KANSAS CITY FACILITY



**Burns &
McDonnell**
SINCE 1898

Figure 1-3
SWMU 2 - OLD BLUE RIVER
"W" LANDFILL



LEGEND

- RFI DIRECT-PUSH BORING
LOCATION FOR GROUNDWATER
- SWMU BOUNDARY
- APPROXIMATE LANDFILL
BOUNDARY FROM 1988
- REMCOR REPORT



Figure 1-4
SWMU 3
SOUTH OF BAR FAB
LANDFILL
AK STEEL KANSAS CITY FACILITY

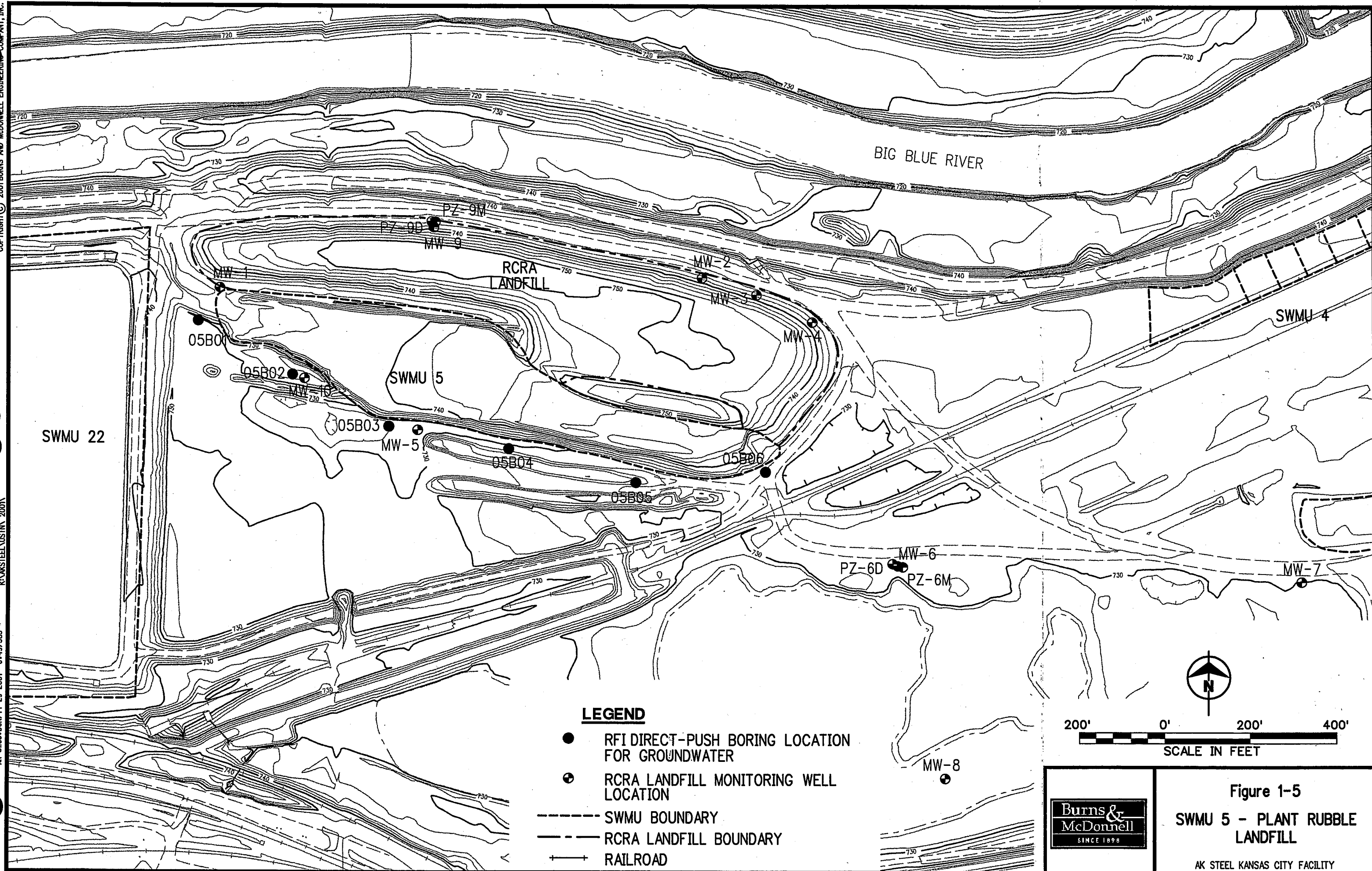


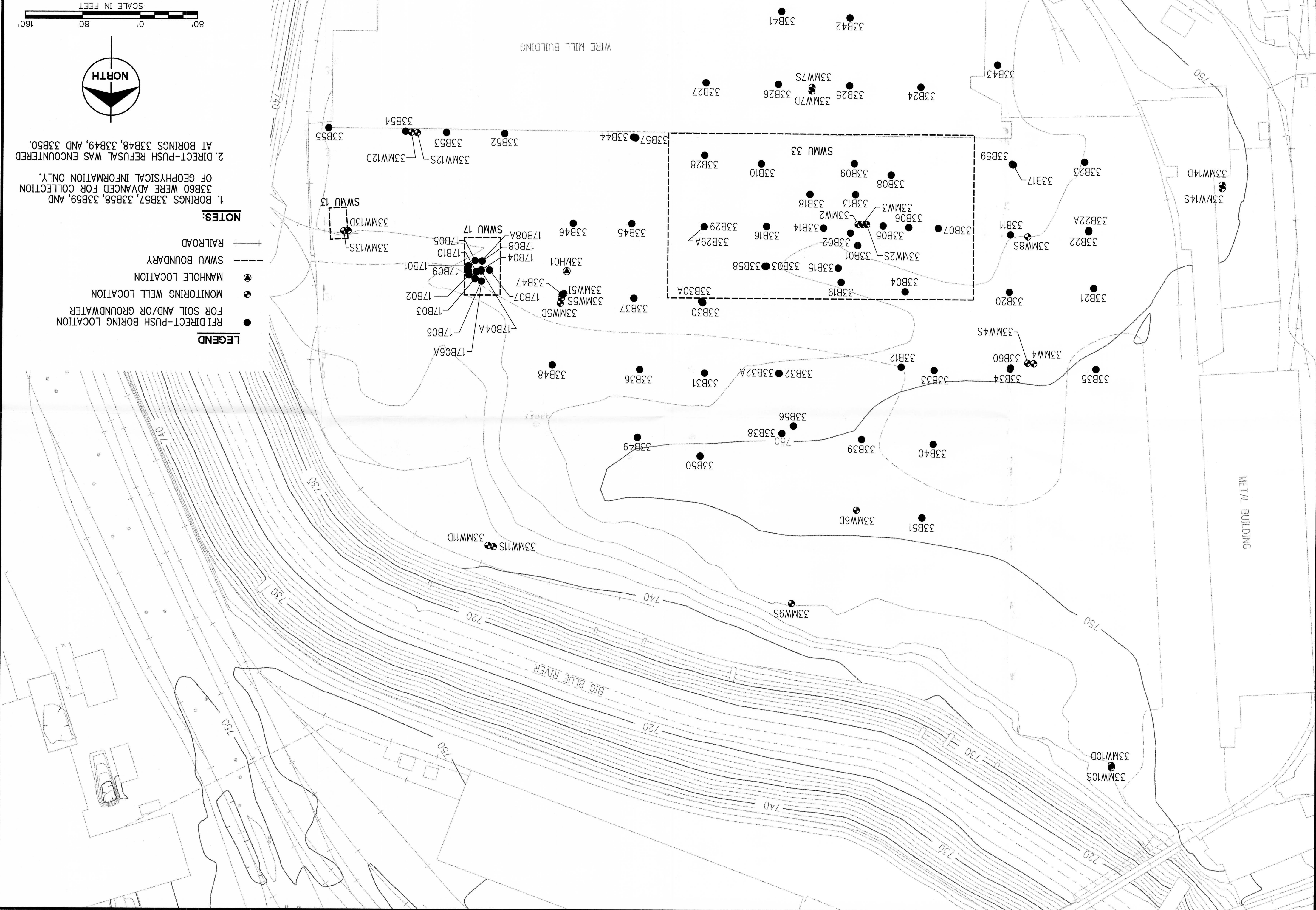


Figure 1-6

**SWMU 7 - NO. 1 MELT SHOP
BAGHOUSE DUST TANK**

AK STEEL KANSAS CITY FACILITY





2.0 CORRECTIVE MEASURES OBJECTIVES

2.1 CORRECTIVE MEASURES OBJECTIVES

The overall corrective measure objective is to mitigate potential current and future risks to human health and the environment. A human health risk assessment (HHRA) and an ecological risk assessment (ERA) were conducted and presented as Appendices X and Y to the RFI Report (BMWCI, 1999). Information regarding media of concern, potential contaminants of concern, potentially exposed populations and pathways, and exposure assumptions are considered useful for the purposes of this CMS Work Plan. The following sections provide a discussion of points of compliance, proposed target media cleanup standards, and additional data needs for the CMS.

2.2 COMPLIANCE POINTS

Land use near the Facility is characterized by medium to heavy industrial development, and the Facility is zoned M2A – Heavy Industrial by the city of Kansas City, Missouri. Future use of the Facility is anticipated to remain industrial. Localized residential developments are located southeast and west of the Facility. Overland access to the Facility by the public is limited by perimeter fencing, gates, and guards throughout most of the Facility. The Facility is marginally accessible from the Blue and Missouri Rivers and from Rock Creek.

Major surface water bodies near the Facility include the Blue River, Rock Creek, and the Missouri River. The majority of the Facility lies within the 100-year floodplain.

Groundwater flow beneath the Facility is generally to the north-northeast toward the Blue and Missouri Rivers. Groundwater is not used for any purpose at the Facility, and potable water is supplied by the city of Kansas City, Missouri. The anticipated future uses for groundwater beneath the Facility are expected to remain unchanged.

Points of compliance are the site-specific locations at which the concentrations of individual constituents should meet the media cleanup standards. Definitive points of compliance for each SWMU or AOC will be developed as part of the CMS. For surficial exposure scenarios (i.e., direct contact with soils or groundwater, inhalation of vapors, etc.), the point of compliance will likely be established within the SWMU boundary. The points of compliance for exposures based upon migration of contamination within groundwater are anticipated to be the boundary of the area of contamination.

2.3 DEVELOPMENT OF REMEDIAL ACTION GOALS

For regulated units (SWMUs), the owner/operator is required to provide information to support USEPA's selection and development of media-specific protection standards for constituents found in the SWMUs or AOCs. The protection standards are derived from site-specific chemical, media, and future land use considerations. The standards are intended to meet requirements for protection of human health and the environment. Potential protection standards were developed for groundwater and soil and are presented on Tables 2-1 and 2-2. These standards are based on promulgated federal and state standards in combination with risk-assessment derived standards.

It should be emphasized that some of the standards presented are not promulgated regulatory levels but are corrective action objectives (CAOs) that were developed from site-specific risk analysis. Appendix A presents the calculation of the risk-assessment based CAOs. For determination of CAOs, information from the RFI Report (BMWCI, 1999) was reviewed. The CAOs incorporated media of concern, potential contaminants of concern, potentially exposed populations and pathways, and exposure assumptions from the HHRA of the RFI Report (BMWCI, 1999). CAOs were only calculated for those chemicals identified as COPCs.

Included in the discussion of potential protection standards are the Cleanup Levels for Missouri (CALM) that MDNR has developed for sites participating in Missouri's Voluntary Cleanup Program. The CALM process develops cleanup levels for soil and groundwater based various on site land use scenarios. It uses a tiered approach that integrates site assessment and response actions with human health and ecological risk assessment. It should be noted that the cleanup levels established in CALM are guidelines, which were not developed for the RCRA corrective action process.

In addition, USEPA Region 9 has developed Preliminary Remediation Goals (PRGs) for evaluation and cleanup of contaminated sites. This guidance provides contaminant-specific PRGs for soils based on assumed risk threshold and exposure scenarios. The Region 9 PRGs are risk-assessment based concentrations that are calculated without site-specific data. The Region 9 PRGs are guidelines and not enforceable standards.

2.3.1 Soil Protection Standards

The potential protection standards for soil are discussed in this section. The potential protection standards for soil for VOC, SVOC, and metal constituents are summarized in the following paragraphs and Table 2-1.

- Calculated CAOs (see Appendix A) – CAOs for soil were calculated using site-specific information and risk assessment calculations. Scenarios were examined for a full-time worker and a construction excavation worker.
- Characteristic Hazardous Waste Criteria (40 CFR Part 261.24) – There is an enforceable regulation pertaining to soil analyzed using the Toxicity Characteristic Leaching Procedure (TCLP). If the concentration of a contaminant in a soil sample exceeds the maximum allowed for the toxicity characteristic, the soil is classified as hazardous waste.
- Cleanup Levels for Missouri - The CALM document provides chemical-specific soil target concentrations (STARC). Due to the industrial nature of the facility, Scenario C (Industrial Land Use) was selected. In addition, the CALM document provides STARC for leaching of chemicals to groundwater.
- USEPA Region 9 PRGs – The PRGs established for industrial soil were selected.
- USEPA Soil Screening Guidance (USEPA, 1996) – The generic soil screening levels (SSLs) for the migration to groundwater pathway using a dilution attenuation factor (DAF) were used during the RFI as a screening criteria for the nature and extent of contamination. Section 4.2.6.1 of the RFI Report (BMWCI, 1999) explains the rationale for use of this criteria.
- Revised Interim Soil Lead Guidance for CERCLA Site and RCRA Corrective Action Facilities (OSWER Directive #9355.4-12, USEPA, August 1994) and Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (OSWER Directive #9200.4-27, USEPA, August 1998) – These guidance documents recommend screening levels for lead in soil for residential land use at 400 mg/kg

and describes how to develop site-specific PRGs for lead with residential land use. Industrial settings are not discussed.

- Toxic Substances Control Act (TSCA), Section 403 (Federal Register/Vol. 66, No. 4/Friday, January 5, 2001, Lead; Identification of Dangerous Levels of Lead; Final Rule) – TSCA Section 403 establishes standards for lead-based paint hazards in housing and child-occupied facilities (i.e., residential settings). In the final rule, the soil lead hazard standard was set at 400 mg/kg for bare soil in play areas and an average of 1,200 mg/kg for bare soil in non-play areas. This standard is not necessarily applicable to the site as it is intended to be used for lead-based paint hazards in residential settings and is generic in nature, whereas RCRA standards are developed using site-specific information.

The proposed target media cleanup standards for soil are the CAOs that were calculated in Appendix A and presented on Table 2-1.

2.3.2 Groundwater Protection Standards

The potential protection standards for groundwater are discussed in this section. The potential protection standards for groundwater for VOC, SVOC, and metal constituents are summarized in the following paragraphs and Table 2-2.

- Calculated CAOs (see Appendix A) – CAOs for groundwater were calculated using site-specific information and risk assessment calculations. Scenarios were examined for a full-time worker and a construction excavation worker.
- Safe Drinking Water Act (40 CFR Part 141 Subpart B) – Maximum Contaminant Levels (MCLs), established by the Safe Drinking Water Act, are defined as the “maximum permissible level of a contaminant in water which is delivered to any user of a public water system.” Although groundwater at the Facility is not used as a potable water source, MCLs are often used to indicate whether site releases to groundwater pose a health risk to human health and the environment.
- Missouri Water Quality Standards (10 CSR 20-7.031) – The concentrations in Column VII of Table A of the Missouri Water Quality Standards have been developed by MDNR to protect

the quality of groundwater resources. In addition, water quality standards have been developed by MDNR to protect the quality of surface water resources based on the use(s) of the surface water. These standards may be applicable to groundwater if contaminants are migrating toward surface water bodies. Table A of the Missouri Water Quality Standards presents these standards based upon use designation. Major surface water bodies near the Facility include the Blue River, Rock Creek, and the Missouri River. The following classification and use designations have been made for these water bodies:

- Blue River – A continuous flowing stream that has been designated for livestock and wildlife watering (Category V), aquatic life protection (Category I), human health protection for fish consumption (Category II), and industrial uses (no category).
 - Rock Creek – An intermittent stream that that has been designated for livestock and wildlife watering (Category V), aquatic life protection (Category I), and human health protection for fish consumption (Category II).
 - Missouri River – A continuous flowing stream that has been designated for irrigation (Category IV), livestock and wildlife watering (Category V), aquatic life protection (Category I), boating and canoeing (no category), drinking water supply (Category III), and industrial uses (no category).
- Cleanup Levels for Missouri - The CALM document provides chemical-specific groundwater target concentrations (GTARC).
 - National Recommended Water Quality Criteria – Section 304(a)(1) of the Clean Water Act requires EPA to develop and publish water quality criteria recommendations for surface water bodies of the United States. These criteria may be applicable to groundwater if contaminants are migrating toward surface water bodies. The criteria set criteria maximum concentrations (CMC) and criteria continuous concentrations (CCCs) for protection of fresh water organisms. Criteria are also established for human consumption of aquatic organisms.
 - USEPA Region 9 PRGs – The PRGs established to protect from exposure to tap water use were selected for groundwater, although this media was not used as a potable water source. This was conservatively done, since these PRGs are often used to indicate whether site releases to groundwater pose a risk to human health and the environment.

The proposed target media cleanup standards for groundwater are dependent upon the exposure scenario. For worker exposure scenarios, the CAOs that were calculated in Appendix A and presented on Table 2-2 are proposed as target media cleanup standards. For scenarios based upon groundwater migration and subsequent exposure, the target media cleanup standards will be proposed following known upcoming revisions to the Missouri groundwater regulations.

2.4 ADDITIONAL DATA NEEDS

The following sections present additional data that are needed to complete the CMS. These data are needed to appropriately identify and evaluate the remedial alternatives. Detailed information regarding sample collection procedures/methods, required equipment, decontamination of sampling equipment, and handling of investigation derived waste is included in the RFI Workplan (BMWCI, 1996) and *Quality Assurance Project Plan for Groundwater Sampling at the Nail Mill Degreasing Area* (Burns & McDonnell, 2000).

2.4.1 SWMU 3 – South of Bar Fab Landfill

Six groundwater samples were collected via direct-push sampling during the RFI at SWMU 3, the South of Bar Fab Landfill. The groundwater samples were field filtered and analyzed for dissolved lead and cadmium.

Four additional direct-push groundwater samples are proposed. The samples will be located adjacent to previous RFI direct-push borings 03B01, 03B02, 03B03, and 03B08. The samples will be field filtered and analyzed for dissolved lead and cadmium. The approximate locations for the proposed direct-push borings are shown on Figure 2-1, and Table 2-3 outlines the planned sample collection, analysis, and QA/QC samples.

2.4.2 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tanks

During the RFI, a total of 198 surface and subsurface soil samples were collected at various depth intervals and analyzed for lead and cadmium. X-ray fluorescence (XRF) spectroscopy was used to field screen for lead in samples from Borings 07B09 to 07B35.

Nine additional test pit locations are proposed along the perimeter of the No. 1 Melt Shop Building. Soil samples will be collected at four depth intervals (0-0.5 feet, 0.5-2 feet, 2-3 feet, and 3-4 feet) for a total of 36 samples. The samples will be analyzed for lead and cadmium. The approximate locations for the

proposed test pits are shown on Figure 2-2, and Table 2-4 outlines the planned sample collection, analysis, and QA/QC samples.

2.4.3 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area

During both phases of the RFI, subsurface soil samples were collected from 20 direct-push borings and from two monitoring well borings and submitted for laboratory VOC analysis. Groundwater samples were collected from 51 direct-push borings and 20 monitoring wells. Subsequent lab analysis has been performed on groundwater samples from the monitoring wells. The northwestern-most shallow and deep monitoring well cluster (33MW10S/10D) consistently contained elevated levels of VOCs in the deep well (33MW10D). The source of VOC detections in deep well 33MW10D is unknown, and it is unclear if these detections are part of the larger plume of VOCs centered around the former degreaser or from off-site.

Four additional monitoring wells (two 2-well clusters) in the intervening area between the 33MW10S/10D well cluster and other well clusters proximal to the source area will allow for a better understanding of whether the plume at 33MW10D is connected to the source area or is migrating from off-site. Groundwater samples will be collected and analyzed for VOCs. The proposed new well cluster locations are shown on Figure 2-3, and Table 2-5 outlines the planned sample collection, analysis, and QA/QC samples.

2.4.4 AOC 8 – “Owl Gun Club” Shooting Park

During the RFI, 122 surface soil and subsurface soil samples were collected for lead analysis from AOC 8. XRF spectroscopy was used to field screen for lead in samples from Borings A08B05 to A08B40.

Nine additional direct-push borings are proposed along the perimeter of AOC 8. Soil samples will be collected at two depth intervals (0-0.5 feet and 0.5-2 feet) for a total of 18 samples. The samples will be analyzed for lead. The proposed direct-push boring locations are shown on Figure 2-4, and Table 2-6 outlines the planned sample collection, analysis, and QA/QC samples.

* * * * *

Table 2-1
Potential Protection Standards for Soil
AK Steel Kansas City Facility

	USEPA ¹ TCLP	CALM STARC ²		USEPA Region 9 ³ PRGs	USEPA ⁴ 20 DAF SSL	Calculated ⁵ CAOs	
		Industrial	GW Leaching			TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Metals	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	5.0	14	-- c	2.7 / 440 d	29	35	125
Barium	100	51000	1700	100000	1600	--	--
Cadmium	1.0	380	11	810	8	79	262
Chromium, Hexavalent	see Total Cr	see Total Cr	see Total Cr	64	38	--	--
Chromium, Trivalent	see Total Cr	see Total Cr	see Total Cr	100000	-- e	--	--
Chromium, Total	5.0	4500	38	450	38	--	--
Lead	5.0	660	-- c	750	400	8360 ³³	8360
Mercury	0.2	1	3.2	610	2	--	--
Selenium	1.0	970	4.3	10000	5	625	2083
Silver	5.0	450	26	10000	34	--	--
Volatiles	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acetone (2-Propanone)	--	8700	--	6200	16	--	--
Benzene	0.5	13	0.05	1.5	0.03	3.2	10.6
Bromodichloromethane	--	41	0.7	2.4	0.6	--	--
Bromoform (Tribromomethane)	--	450	1	310	0.8	--	--
Bromomethane (Methyl bromide)	--	--	--	13	0.2	--	--
Carbon Disulfide	--	721	--	720	32	--	--
Carbon Tetrachloride	0.5	5	0.13	0.53	0.07	--	--
Chlorobenzene (Monochlorobenzene)	100	180	2.8	540	1	--	--
Chloroethane (Monochloroethane, Ethyl Chloride)	--	--	--	6.5	--	--	--
Chloroform	6.0	1	0.6	0.52	0.6	--	--
Chloromethane (Methyl chloride)	--	150	0.02	2.7	--	--	--
2-Chloroethyl Vinyl Ether	--	--	--	--	--	--	--
Dibromochloromethane	--	77	0.8	2.7	0.4	--	--
1,1-Dichloroethane	--	--	--	2100	23	--	--
1,2-Dichloroethane (EDC)	0.5	6	0.02	0.76	0.02	4.0	13.5
1,1-Dichloroethene (1,1-Dichloroethylene)	0.7	1	0.09	0.12	0.06	2.8	27.9
1,2-Dichloroethene (total)	--	see cis-/trans-	see cis-/trans-	see cis-/trans-	see cis-/trans-	see cis-/trans-	see cis-/trans-
cis-1,2-Dichloroethene	--	1200	0.5	150	0.4	1250	1682
trans-1,2-Dichloroethene	--	3100	1	210	0.7	2500	3969
1,2-Dichloropropane	--	25	0.04	0.77	0.03	--	--
cis-1,3-Dichloropropene	--	See Dichloropropene	See Dichloropropene	See Dichloropropene	0.004	--	--
trans-1,3-Dichloropropene	--	See Dichloropropene	See Dichloropropene	See Dichloropropene	0.004	--	--
Dichloropropene	--	2	0.004	1.6	--	--	--
Ethylbenzene	--	400	32	230	13	--	--
2-Hexanone (Methyl Butyl Ketone)	--	--	--	--	--	--	--
Methylene Chloride	--	150	0.02	21	0.02	603	3797
Methyl Ethyl Ketone (2-Butanone)	--	16000	--	28000	--	--	--

Table 2-1
Potential Protection Standards for Soil
AK Steel Kansas City Facility

	USEPA ¹ TCLP	CALM STARC ²		USEPA Region 9 ³ PRGs	USEPA ⁴ 20 DAF SSL	Calculated ⁵ CAOs	
		Industrial	GW Leaching			TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Volatiles	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
4-Methyl-2-Pentanone (Hexone, MIBK)	--	2300	--	2900	--	--	--
Styrene	--	1500	9.4	1700	4	--	--
1,1,2,2-Tetrachloroethane	--	5	0.004	0.038	0.003	--	--
Tetrachloroethene	0.7	120	0.1	19	0.06	200	290
Toluene	--	650	3.7	520	12	--	--
1,1,1-Trichloroethane	--	1200	3.5	1400	2	--	--
1,1,2-Trichloroethane	--	14	0.04	1.9	0.02	44	440
Trichloroethene	0.5	89	0.1	6.1	0.06	200	1654
Vinyl Acetate	--	--	--	1400	170	--	--
Vinyl Chloride	0.2	0.6	0.02	0.83	0.01	18	60
Xylene (total)	--	418	16	210	see o-, m-, p-Xylenes	--	--
m-Xylene	--	see Total Xylene	see Total Xylene	see Total Xylene	210	--	--
o-Xylene	--	see Total Xylene	see Total Xylene	see Total Xylene	190	--	--
p-Xylene	--	see Total Xylene	see Total Xylene	see Total Xylene	200	--	--
Semivolatiles	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acenaphthene	--	5400	1000	38000	570	--	--
Acenaphthylene	--	--	--	--	--	--	--
Anthracene	--	--	--	100000	12000	--	--
Benzo(a)anthracene (Benz(a)anthracene)	--	4	0.2	2.9	2	29	29
Benzo(b)fluoranthene	--	4	0.6	2.9	5	14	14
Benzo(k)fluoranthene	--	32	0.6	29	49	7.5	7.5
Benzo(g,h,i)perylene	--	--	--	--	--	--	--
Benzo(a)pyrene	--	0.6	24	0.29	8	13	13
Benzoic Acid	--	920000	--	100000	400	--	--
Benzyl alcohol	--	--	--	100000	--	--	--
4-Bromophenyl phenyl ether	--	150	--	--	--	--	--
Butyl benzyl phthalate	--	930	20000	100000	930	--	--
4-Chloroaniline (p-Chloroaniline)	--	920	--	3500	0.7	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	--	2	0.0001	0.62	0.0004	--	--
bis(2-Chloroisopropyl)ether	--	27	2.6	8.1	--	--	--
bis(2-ethylhexyl)phthalate	--	1800	11000	180	3600	3247	16994
4-Chloro-3-methylphenol	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	27000	--	--	--
2-Chlorophenol	--	450	1.9	240	4	--	--
4-Chlorophenyl phenyl ether	--	--	--	--	--	--	--
Chrysene	--	140	0.2	290	160	4.9	4.9
Dibenzo(a,h)anthracene	--	0.6	2	0.29	2	24	73

Table 2-1
Potential Protection Standards for Soil
AK Steel Kansas City Facility

	USEPA ¹		CALM STARC ²		USEPA Region 9 ³	USEPA ⁴	Calculated ⁵ CAOs	
	TCLP		Industrial	GW Leaching			TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Semivolatiles	(mg/L)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Dibenzofuran	--		360	--	5100	--	--	--
Di-n-butyl phthalate	--		2300	11000	88000	2300	--	--
1,2-Dichlorobenzene (ortho-dichlorobenzene)	--		600	45	370	17	--	--
1,3-Dichlorobenzene (meta-dichlorobenzene)	--		--	--	52	--	--	--
1,4-Dichlorobenzene (para-dichlorobenzene)	7.5		51	5.6	8.1	2	--	--
3,3'-Dichlorobenzidine	--		14	0.003	5.5	0.007	--	--
2,4-Dichlorophenol	--		690	0.4	2600	1	--	--
Diethyl phthalate	--		2000	830	100000	470	--	--
2,4-Dimethylphenol	--		4600	14	18000	9	--	--
Dimethylphthalate	--		1360	2100	100000	--	--	--
4,6-Dinitro-2-methylphenol	--		--	--	--	--	--	--
2,4-Dinitrophenol	--		460	0.14	1800	0.3	--	--
2,4-Dinitrotoluene	0.13	a	3	10	1800	0.0008	--	--
2,6-Dinitrotoluene	--		3	10	880	0.0007	--	--
Di-n-octylphthalate	--		0.3	--	10000	10000	--	--
Fluoranthene	--		5200	3800	30000	4300	--	--
Fluorene	--		3600	2100	33000	560	--	--
Hexachlorobenzene	0.13	a	3	6.5	1.5	2	--	--
Hexachlorobutadiene	0.50		46	6.3	32	2	--	--
Hexachlorocyclopentadiene	--		17	1200	5900	400	--	--
Hexachloroethane	3.0		230	0.2	180	0.5	--	--
Indeno(1,2,3-cd)pyrene	--		11	1.8	2.9	14	0.59	0.59
Isophorone	--		4570	0.7	2600	0.5	--	--
2-Methylnaphthalene	--		--	--	--	--	--	--
2-Methylphenol (o-Cresol)	200	b	12000	--	44000	15	--	--
4-Methylphenol (p-Cresol)	200	b	820	--	4400	--	--	--
Naphthalene	--		240	24	190	84	--	--
2-Nitroaniline	--		--	--	50	--	--	--
3-Nitroaniline	--		--	--	--	--	--	--
4-Nitroaniline	--		--	--	--	--	--	--
Nitrobenzene	2.0		35	0.2	110	0.1	--	--
2-Nitrophenol	--		--	--	--	--	--	--
4-Nitrophenol	--		--	--	7000	--	--	--
N-Nitroso-di-n-propylamine	--		1300	--	0.35	0.00005	--	--
N-Nitrosodiphenylamine	--		--	0.8	500	1	--	--
Pentachlorophenol	100		25	0.07	11	0.03	--	--
Phenanthrene	--		--	--	--	--	--	--
Phenol	--		17000	21	100000	100	--	--

Table 2-1
Potential Protection Standards for Soil
 AK Steel Kansas City Facility

	USEPA ¹ TCLP	CALM STARC ²		USEPA Region 9 ³ PRGs	USEPA ⁴ 20 DAF SSL	Calculated ⁵ CAOs	
		Industrial	GW Leaching			TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Semivolatiles	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Pyrene	--	6900	12000	54000	4200	--	--
1,2,4-Trichlorobenzene	--	54	--	3000	5	--	--
2,4,5-Trichlorophenol	400	23000	500	88000	270	--	--
2,4,6-Trichlorophenol	2.0	510	0.1	220	0.2	--	--

CALM = Cleanup Levels for Missouri

DAF = Dilution Attenuation Factor

GW = Groundwater Leaching

HI = Hazard Index

PRG = Preliminary Remediation Goals

SSL = Soil Screening Level

STARC = Soil Target Concentrations

TCLP = Toxicity Characteristic Leaching Procedure

TCRL = Target Cancer Risk Level

USEPA = United States Environmental Protection Agency

1 = Toxicity Characteristic Leaching Procedure (USEPA SW-846 Method 1311) regulatory limits from 40 CFR 261.24

2 = Cleanup Levels for Missouri. Tier 1 Soil and Groundwater Cleanup Standards for the Voluntary Cleanup Program (Missouri Department of Natural Resources, September 1, 2001 Update). Values are provided for Scenario C (Industrial Use) and Leaching to Groundwater.

3 = Preliminary Remediation Goals Table (USEPA Region 9, November 1, 2000). These levels are from the Industrial Soil column.

4 = Soil Screening Guidance: Technical Background Document (USEPA, 1996). The values provided are from the migration to groundwater pathway for a dilution attenuation factor (DAF) of 20. These values were used during the RFI to screen for nature and extent of contamination.

5 = See Appendix A. Site-Specific CAOs were calculated for identified chemicals of potential concern. The calculations took into account site-specific conditions and exposure scenarios.

a = The analytical quantitation limit is greater than the regulatory limit. Therefore, the quantitation limit becomes the regulated level.

b = When cresols are reported as individual compounds, the results should be added together. The regulatory limit is for Total Cresols.

c = Reliable partitioning coefficient data necessary for calculating the groundwater leaching concentration was not identified for this contaminant.

d = Two values are provided in the USEPA Region 9 PRG table. The non-cancer endpoint industrial PRG was 440 mg/kg and the cancer endpoint was 2.7 mg/kg.

e = For trivalent chromium, the chemical-specific properties are such that the migration to groundwater pathway is not of concern at any soil concentration.

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

	SDWA ¹ MCL (mg/L)	Missouri ² WQS (mg/L)	CALM ³ GTARC (mg/L)	USEPA Region 9 ⁴ PRGs (mg/L)	Calculated ⁵ CAOs	
					TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Metals						
Arsenic	0.05	0.05	0.05	0.000045	1.8	1.8
Barium	2.00	2.00	2.00	2.6	--	--
Cadmium	0.005	0.005	0.005	0.018	6.1	20.2
Chromium, Hexavalent	see Total Cr	see Total Cr	see Total Cr	0.110	--	--
Chromium, Trivalent	see Total Cr	see Total Cr	see Total Cr	55	--	--
Chromium, Total	0.10	0.10	0.10	--	--	--
Lead	0.015 a	0.015	0.015	--	--	--
Mercury	0.002	0.002	0.002	0.011	--	--
Selenium	0.05	0.05	0.05	0.180	30	101
Silver	0.10 b	0.05	0.10	0.180	--	--
Volatiles						
Acetone (2-Propanone)	--	--	--	610	--	--
Benzene	5	5	5	0.35	180	590
Bromodichloromethane	100/80 c	100	80	0.18	--	--
Bromoform (Tribromomethane)	100/80 c	100	80	8.5	--	--
Bromomethane (Methyl bromide)	--	48 / 10 d	--	8.7	--	--
Carbon Disulfide	--	--	--	1000	--	--
Carbon Tetrachloride	5	5	5	0.17	--	--
Chlorobenzene (Monochlorobenzene)	100	100	100	110	--	--
Chloroethane (Monochloroethane, Ethyl Chloride)	--	--	--	4.6	--	--
Chloroform	100/80 c	100	80	0.16	--	--
Chloromethane (Methyl chloride)	--	5	--	1.5	--	--
2-Chloroethyl Vinyl Ether	--	--	--	--	--	--
Dibromochloromethane	100/80 c	100	80	0.13	--	--
1,1-Dichloroethane	--	--	--	810	--	--
1,2-Dichloroethane (EDC)	5	5	5	0.12	540	1800
1,1-Dichloroethene (1,1-Dichloroethylene)	7	7	7	0.046	1300	11400
1,2-Dichloroethene (total)	see cis-/trans-	see cis-/trans-	see cis-/trans-	see cis-/trans-	--	--
cis-1,2-Dichloroethene	70	70	70	61	6100	20200
trans-1,2-Dichloroethene	100	100	100	120	12000	40000
1,2-Dichloropropane	5	100	5	0.16	--	--
cis-1,3-Dichloropropene	--	See Dichloropropene	See Dichloropropene	See Dichloropropene	--	--
trans-1,3-Dichloropropene	--	See Dichloropropene	See Dichloropropene	See Dichloropropene	--	--
Dichloropropene	--	87	0.4	0.4	--	--
Ethylbenzene	700	700	700	1300	--	--
2-Hexanone (Methyl Butyl Ketone)	--	--	--	--	--	--
Methylene Chloride	5	5	5	4.3	54000	269000
Methyl Ethyl Ketone (2-Butanone)	--	--	--	1900	--	--

Why are they not using the web??

Table 2-2
Potential Protection Standards for Groundwater
AK Steel Kansas City Facility

	SDWA ¹ MCL (µg/L)	Missouri ² WQS (µg/L)	CALM ³ GTARC (µg/L)	USEPA Region 9 ⁴ PRGs (µg/L)	Calculated ⁵ CAOs	
					TCRL=1E-05; HI=0.3 (µg/L)	TCRL=1E-04; HI=1 (µg/L)
Volatiles						
4-Methyl-2-Pentanone (Hexone, MIBK)	--	--	--	160	--	--
Styrene	100	100	100	1600	--	--
1,1,2,2-Tetrachloroethane	--	0.17	0.3	0.055	--	--
Tetrachloroethene	5	5	5	1.1	150	510
Toluene	1000	100	150	720	--	--
1,1,1-Trichloroethane	200	200	200	540	--	--
1,1,2-Trichloroethane	5	5	5	0.2	2900	9600
Trichloroethene	5	5	5	1.6	180	610
Vinyl Acetate	--	--	--	410	--	--
Vinyl Chloride	2	2	2	0.041	2500	8200
Xylene (total)	10000	10000	320	1400	--	--
m-Xylene	see total Xylene	see total Xylene	see total Xylene	see total Xylene	--	--
o-Xylene	see total Xylene	see total Xylene	see total Xylene	see total Xylene	--	--
p-Xylene	see total Xylene	see total Xylene	see total Xylene	see total Xylene	--	--
Semivolatiles						
Acenaphthene	--	1200	1200	370	--	--
Acenaphthylene	--	--	--	--	--	--
Anthracene	--	9600	9.6	1800	--	--
Benzo(a)anthracene (Benz(a)anthracene)	--	0.0044	0.0044	0.092	9.4	9.4
Benzo(b)fluoranthene	--	0.0044	0.0044	0.092	1.5	1.5
Benzo(k)fluoranthene	--	0.0044	0.0044	0.92	0.8	0.8
Benzo(g,h,i)perylene	--	--	--	--	--	--
Benzo(a)pyrene	0.2	0.2	0.2	0.0092	1.6	1.6
Benzoic Acid	--	--	--	150000	--	--
Benzyl alcohol	--	--	--	11000	--	--
4-Bromophenyl phenyl ether	--	--	--	--	--	--
Butyl benzyl phthalate	--	3000	3000	7300	--	--
4-Chloroaniline (p-Chloroaniline)	--	--	--	150	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--
bis(2-Chloroethyl)ether	--	0.03	0.03	0.0098	--	--
bis(2-Chloroisopropyl)ether	--	1400 / 300	300	0.27	--	--
bis(2-ethylhexyl)phthalate	6	6	6	4.8	340	340
4-Chloro-3-methylphenol	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	490	--	--
2-Chlorophenol	--	0.1	40	3	--	--
4-Chlorophenyl phenyl ether	--	--	--	--	--	--
Chrysene	--	0.0044	0.0044	9.2	1.6	1.6
Dibenzo(a,h)anthracene	--	0.0044	0.0044	0.0092	0.72	2.49

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

	SDWA ¹ MCL	Missouri ² WQS	CALM ³ GTARC	USEPA Region 9 ⁴ PRGs	Calculated ⁵ CAOs	
					TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Semivolatiles	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Dibenzofuran	--	--	--	24	--	--
Di-n-butyl phthalate	--	2700	2700	3600	--	--
1,2-Dichlorobenzene (ortho-dichlorobenzene)	600	600	600	370	--	--
1,3-Dichlorobenzene (meta-dichlorobenzene)	--	600	--	5.5	--	--
1,4-Dichlorobenzene (para-dichlorobenzene)	75	75	75	0.50	--	--
3,3'-Dichlorobenzidine	--	0.04	0.04	0.15	--	--
2,4-Dichlorophenol	--	93	20	110	--	--
Diethyl phthalate	--	23000	23000	29000	--	--
2,4-Dimethylphenol	--	540	540	730	--	--
Dimethylphthalate	--	313000	313000	360000	--	--
4,6-Dinitro-2-methylphenol	--	13	--	--	--	--
2,4-Dinitrophenol	--	70	70	73	--	--
2,4-Dinitrotoluene	--	0.11	0.05	73	--	--
2,6-Dinitrotoluene	--	--	0.05	36	--	--
Di-n-octylphthalate	--	--	--	730	--	--
Fluoranthene	--	300	300	1500	--	--
Fluorene	--	1300	1300	240	--	--
Hexachlorobenzene	1	1	1	0.042	--	--
Hexachlorobutadiene	--	0.45	1	0.86	--	--
Hexachlorocyclopentadiene	50	50	50	260	--	--
Hexachloroethane	--	1.9	1	4.8	--	--
Indeno(1,2,3-cd)pyrene	--	0.0044	0.0044	0.092	0.022	0.022
Isophorone	--	36	100	71	--	--
2-Methylnaphthalene	--	--	--	--	--	--
2-Methylphenol (o-Cresol)	--	--	--	1800	--	--
4-Methylphenol (p-Cresol)	--	--	--	180	--	--
Naphthalene	--	20	100	6.2	--	--
2-Nitroaniline	--	--	--	2.1	--	--
3-Nitroaniline	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--
Nitrobenzene	--	17	17	3.4	--	--
2-Nitrophenol	--	--	--	--	--	--
4-Nitrophenol	--	60	--	290	--	--
N-Nitroso-di-n-propylamine	--	--	--	0.0096	--	--
N-Nitrosodiphenylamine	--	5	5	14	--	--
Pentachlorophenol	1	1	1	0.56	--	--
Phenanthrene	--	--	--	--	--	--
Phenol	--	300	4000	22000	--	--

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

Semivolatiles	SDWA ¹ MCL	Missouri ² WQS	CALM ³ GTARC	USEPA Region 9 ⁴ PRGs	Calculated ⁵ CAOs	
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	TCRL=1E-05; HI=0.3	TCRL=1E-04; HI=1
Pyrene	--	960	960	180	--	--
1,2,4-Trichlorobenzene	70	70	70	190	--	--
2,4,5-Trichlorophenol	--	2600	2600	3600	--	--
2,4,6-Trichlorophenol	--	2	3	6.1	--	--

CALM = Cleanup Levels for Missouri
 CAO = Corrective Action Objective
 GTARC = Groundwater Target Concentrations
 HI = Hazard Index
 MCL = Maximum Contaminant Level

PRG = Preliminary Remediation Goals
 SDWA = Safe Drinking Water Act
 TCRL = Target Cancer Risk Level
 USEPA = United States Environmental Protection Agency
 WQS = Water Quality Standard

- 1 = National Primary Drinking Water Standards (USEPA, March 2001)
 2 = Missouri Water Quality Standards (10 CSR 20-7, October 31, 1999). These levels are from Column VII of Table A of the Missouri WQS and are applicable to groundwater leaving AK Steel property.
 3 = Cleanup Levels for Missouri. Tier 1 Soil and Groundwater Cleanup Standards for the Voluntary Cleanup Program (Missouri Department of Natural Resources, September 1, 2001 Update).
 4 = Preliminary Remediation Goals Table (USEPA Region 9, November 1, 2000). These levels are from the Tap Water column.
 5 = See Appendix A. Site-Specific CAOs were calculated for identified chemicals of potential concern. The calculations took into account site-specific conditions and exposure scenarios.
- a = Lead is regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water sample exceed the action level, water system must take addition steps. The action level of lead is 0.015 mg/L.
- b = Silver does not have an MCL. Instead, USEPA has set a maximum contaminant level goal (MCLG). The MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are non-enforceable public health goals.
- c = The MCL for total trihalomethanes is 100 µg/L. The MCL decreases to 80 µg/L on January 1, 2002.
- d = Two values were given in Column VII for methyl bromide. The value of 48 µg/L was provided under the Volatile Organics section. The value of 10 µg/L was provided under the Health Advisory Levels section.
- e = Two values were given in Column VII for bis(2-chloroisopropyl)ether. The value of 1400 µg/L was provided under the the Organics section. The value of 300 µg/L was provided in the Health Advisory Levels section.

Table 2-2
Potential Protection Standards for Groundwater
AK Steel Kansas City Facility

	Missouri WQS ¹					USEPA Recommended WQC ²			
	I	II	III	IV	V	Freshwater		Human Consumption:	
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Org (µg/L)	Org Only (µg/L)
Metals									
Arsenic	20	--	50	100	--	340	150	0.018	0.14
Barium	--	--	2000	--	--	--	--	1000	--
Cadmium	see below abc	--	5	--	--	4.3	2.2	--	--
Chromium, Hexavalent	see Total Cr	--	see Total Cr	see Total Cr	--	16	11	--	--
Chromium, Trivalent	see Total Cr	--	see Total Cr	see Total Cr	--	570	74	--	--
Chromium, Total	see below ab	--	100	100	--	--	--	--	--
Lead	see below ac	--	15	--	--	65	2.5	--	--
Mercury	see below a	--	2	--	--	1.4	0.77	0.50	0.051
Selenium	5	--	50	--	--	--	5	170	11000
Silver	see below c	--	50	--	--	3.40	--	--	--
Volatiles	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Acetone (2-Propanone)	--	--	--	--	--	--	--	--	--
Benzene	--	71	5	--	--	--	--	1.2	71
Bromodichloromethane	--	46	100	--	--	--	--	0.56	46
Bromoform (Tribromomethane)	--	365	100	--	--	--	--	4.3	360
Bromomethane (Methyl bromide)	--	4800	48 / 10	--	--	--	--	48	4000
Carbon Disulfide	--	--	--	--	--	--	--	--	--
Carbon Tetrachloride	--	5	5	--	--	--	--	0.25	4.4
Chlorobenzene (Monochlorobenzene)	--	21000	100	--	--	--	--	680	21000
Chloroethane (Monochloroethane, Ethyl Chloride)	--	--	--	--	--	--	--	--	--
Chloroform	--	--	100	--	--	--	--	5.7	470
Chloromethane (Methyl chloride)	--	470	5	--	--	--	--	--	--
2-Chloroethyl Vinyl Ether	--	--	--	--	--	--	--	--	--
Dibromochloromethane	--	35	100	--	--	--	--	0.41	34
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane (EDC)	--	99	5	--	--	--	--	0.38	99
1,1-Dichloroethene (1,1-Dichloroethylene)	--	3.2	7	--	--	--	--	0.057	3.2
1,2-Dichloroethene (total)	--	see cis-/trans-	see cis-/trans-	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	70	--	--	--	--	--	--
trans-1,2-Dichloroethene	--	140000	100	--	--	--	--	700	140000
1,2-Dichloropropane	--	39	100	--	--	--	--	0.52	39
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--
Dichloropropene	--	1700	87	--	--	--	--	10	1700
Ethylbenzene	320	--	700	--	--	--	--	3100	29000
2-Hexanone (Methyl Butyl Ketone)	--	--	--	--	--	--	--	--	--
Methylene Chloride	--	1600	5	--	--	--	--	4.7	1600

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

	Missouri WQS ¹					USEPA Recommended WQC ²			
	I	II	III	IV	V	Freshwater		Human Consumption:	
						CMC	CCC	Water + Org	Org Only
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Volatiles									
Methyl Ethyl Ketone (2-Butanone)	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Hexone, MIBK)	--	--	--	--	--	--	--	--	--
Styrene	--	--	100	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	--	11	0.17	--	--	--	--	0.17	11
Tetrachloroethene	--	9	5	--	--	--	--	0.8	8.85
Toluene	--	200000	1000	--	--	--	--	6800	200000
1,1,1-Trichloroethane	--	--	200	--	--	--	--	--	--
1,1,2-Trichloroethane	--	42	5	--	--	--	--	0.6	42
Trichloroethene	--	80	5	--	--	--	--	2.7	81
Vinyl Acetate	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	525	2	--	--	--	--	2	525
Xylene (total)	--	--	10000	--	--	--	--	--	--
m-Xylene	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--
p-Xylene	--	--	--	--	--	--	--	--	--
Semivolatiles	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Acenaphthene	--	2700	1200	--	--	--	--	1200	2700
Acenaphthylene	--	--	--	--	--	--	--	--	--
Anthracene	--	110000	9600	--	--	--	--	9600	110000
Benzo(a)anthracene (Benz(a)anthracene)	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Benzo(b)fluoranthene	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Benzo(k)fluoranthene	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	0.049	0.2	--	--	--	--	0.0044	0.049
Benzoic Acid	--	--	--	--	--	--	--	--	--
Benzyl alcohol	--	--	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	--	--	--	--	--	--	--	--	--
Butyl benzyl phthalate	--	5200	3000	--	--	--	--	3000	5200
4-Chloroaniline (p-Chloroaniline)	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	--	4360	1400	--	--	--	--	0.031	1.4
bis(2-Chloroisopropyl)ether	--	1.4	0.03	--	--	--	--	1400	170000
bis(2-ethylhexyl)phthalate	--	5.9	6	--	--	--	--	1.8	5.9
4-Chloro-3-methylphenol	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	4300	--	--	--	--	--	--	1700	4300
2-Chlorophenol	--	400	0.1	--	--	--	--	120	400
4-Chlorophenyl phenyl ether	--	--	--	--	--	--	--	--	--

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

	Missouri WQS ¹					USEPA Recommended WQC ²			
	I	II	III	IV	V	Freshwater		Human Consumption:	
						CMC	CCC	Water + Org	Org Only
Semivolatiles	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Chrysene	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Dibenzo(a,h)anthracene	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Dibenzofuran	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	12000	2700	--	--	--	--	2700	12000
1,2-Dichlorobenzene (ortho-dichlorobenzene)	--	2600	600	--	--	--	--	2700	17000
1,3-Dichlorobenzene (meta-dichlorobenzene)	--	2600	600	--	--	--	--	400	2600
1,4-Dichlorobenzene (para-dichlorobenzene)	--	2600	75	--	--	--	--	400	2600
3,3'-Dichlorobenzidine	--	0.08	0.04	--	--	--	--	0.04	0.077
2,4-Dichlorophenol	7	790	93	--	--	--	--	93	790
Diethyl phthalate	--	120000	23000	--	--	--	--	23000	120000
2,4-Dimethylphenol	--	2300	540	--	--	--	--	540	2300
Dimethylphthalate	--	2900000	313000	--	--	--	--	313000	2900000
4,6-Dinitro-2-methylphenol	--	765	13	--	--	--	--	13.4	765
2,4-Dinitrophenol	--	14000	70	--	--	--	--	70	14000
2,4-Dinitrotoluene	--	9	0.11	--	--	--	--	0.11	9.1
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--
Fluoranthene	--	370	300	--	--	--	--	300	370
Fluorene	--	14000	1300	--	--	--	--	1300	14000
Hexachlorobenzene	--	0.00074	1	--	--	--	--	0.00075	0.00077
Hexachlorobutadiene	--	50	0.45	--	--	--	--	0.44	50
Hexachlorocyclopentadiene	0.5	--	50	--	--	--	--	240	17000
Hexachloroethane	--	8.7	1.9	--	--	--	--	1.9	8.9
Indeno(1,2,3-cd)pyrene	--	0.049	0.0044	--	--	--	--	0.0044	0.049
Isophorone	--	2600	36	--	--	--	--	36	2600
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--
2-Methylphenol (o-Cresol)	--	--	--	--	--	--	--	--	--
4-Methylphenol (p-Cresol)	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	20	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	1900	17	--	--	--	--	17	1900
2-Nitrophenol	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	60	--	--	--	--	--	--
N-Nitroso-di-n-propylamine	--	1.4	--	--	--	--	--	0.005	1.4
N-Nitrosodiphenylamine	--	16	5	--	--	--	--	5	16

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

	Missouri WQS ¹					USEPA Recommended WQC ²			
	I	II	III	IV	V	Freshwater		Human Consumption:	
	CMC	CCC	Water + Org	Org Only					
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Semivolatiles									
Pentachlorophenol	--	8	1	--	--	19	15	0.28	8.2
Phenanthrene	see below d	--	--	--	--	--	--	--	--
Phenol	100	--	100	--	--	--	--	21000	--
Pyrene	--	11000	960	--	--	--	--	960	11000
1,2,4-Trichlorobenzene	--	940	70	--	--	--	--	260	940
2,4,5-Trichlorophenol	--	9800	2600	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	7	2	--	--	--	--	2.1	6.5

CCC = Contaminant Continuous Concentration

CMC = Contaminant Maximum Concentration

Org = Organism

SDWA = Safe Drinking Water Act

USEPA = United States Environmental Protection Agency

WQC = Water Quality Criteria

WQS = Water Quality Standard

1 = Missouri Water Quality Standards (10 CSR 20-7, October 31, 1999). These levels are from Columns I to V of Table A of the Missouri WQS and may be applicable to surface water bodies in the vicinity of AK Steel.

I = Protection of Aquatic Life

II = Human Health Protection - Fish Consumption

III = Drinking Water Supply

IV = Irrigation

V = Livestock and wildlife watering

2 = National Recommended Water Quality Criteria - Correction (USEPA, April 1999).

Numerous footnotes are appended to these criteria. See USEPA document (EPA 822-Z-99-001) for details.

a = Separate values are available for chronic affects and acute affects (see below).

b = Separate values are available for type of fishery (see below).

c = WQS is dependent upon hardness (see below).

d = WQS is dependent upon pH (see below).

Table 2-2
Potential Protection Standards for Groundwater
 AK Steel Kansas City Facility

Missouri QQS - Column I, Protection of Aquatic Life

Cadmium, $\mu\text{g/L}$	Hardness		
	< 125	125 - 200	>200
Chronic:			
CWF	1.1	1.4	1.8
Lakes	9.1	9.1	9.1
GWWF	9.1	11.8	15.5
LWWF	11.8	16.4	20
Acute:			
CWF	3.7	5.9	8.1
Lakes & GWWF	31	49	68
LWWF	43	68	94

Lead, $\mu\text{g/L}$	Hardness		
	< 125	125 - 200	>200
Chronic:			
all waters	9	16	23
Acute:			
all waters	63	104	150

Silver, $\mu\text{g/L}$	Hardness		
	< 125	125 - 200	>200
Acute:			
all waters	3.5	7	11

Chromium, $\mu\text{g/L}$	
Chronic:	
Lakes	11
CWF, GWWF	42
LWWF	190
Acute:	
Lakes	16
CWF, GWWF	62
LWWF	280

Mercury, $\mu\text{g/L}$	
Chronic:	
all waters	0.5
Acute:	
all waters	2.4

Pentachlorophenol, $\mu\text{g/L}$	
pH=6.5	3.2
pH=7.0	5.3
pH=7.5	8.7
pH=8.0	14
pH=8.5	23

CWF = Cold-water fishery
 GWWF = General warm-water fishery
 LWWF = Limite warm-water fishery

Table 2-3
SWMU 3 - South of Bar Fab Landfill
Groundwater Samples
 AK Steel Kansas City Facility
 AK Steel Property

Sample Point*	Sample Designator	Sample Type	Estimated Depth of Sample (ft)	Chemical Analyses	
				Dissolved Cadmium	Dissolved Lead
03B01A	DW1		Upper 10 ft. of WT	X	X
03B02A	DW1		Upper 10 ft. of WT	X	X
03B03A	DW1		Upper 10 ft. of WT	X	X
	DW1MS	Matrix Spike	Upper 10 ft. of WT	X	X
	DW1MSD	Matrix Spike Duplicate	Upper 10 ft. of WT	X	X
03B08A	DW1		Upper 10 ft. of WT	X	X
	DW1D	Field Duplicate	Upper 10 ft. of WT	X	X

Notes:

- * - Borings will be placed at the approximate locations of the RFI borings.
- Locations shown for QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, etc.
- An explanation of the sample naming/numbering nomenclature is provided in Section II-3.11 of the RFI Workplan.
- Water samples will be field filtered for dissolved metals analysis.

Table 2-4
SWMU 7 - No. 1 Melt Shop Baghouse Dust Tank
Subsurface Soil Samples
 AK Steel Kansas City Facility
 AK Steel Property

Sample Point	Sample Designator	Sample Type	Estimated Depth of Sample (ft)	Chemical Analyses	
				Cadmium	Lead
07TP19	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
07TP20	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
07TP21	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
07TP22	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB3MS	Matrix Spike	2 - 3	X	X
	SB3MSD	Matrix Spike Duplicate	2 - 3	X	X
	SB4		3 - 4	X	X
07TP23	SB1		0 - 0.5	X	X
	SB1D	Field Duplicate	0.5 - 2	X	X
	SB2		1 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
	SB4R	Equipment Rinsate	--	X	X
07TP24	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
07TP25	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
	SB4MS	Matrix Spike	3 - 4	X	X
	SB4MSD	Matrix Spike Duplicate	3 - 4	X	X
07TP26	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB2D	Field Duplicate	1 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
07TP27	SB1		0 - 0.5	X	X
	SB2		0.5 - 2	X	X
	SB3		2 - 3	X	X
	SB4		3 - 4	X	X
	SB4R	Equipment Rinsate	3 - 4	X	X

Notes:

- Locations shown for QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, etc.
- An explanation of the sample naming/numbering nomenclature is provided in Section II-3.11 of the RFI Workplan.

Table 2-5
SWMU 17 - Wire Mill Rinsewater Neutralization Tank
SWMU 33 - Nail Mill Degreasing Area
Groundwater Samples
 AK Steel Kansas City Facility
 AK Steel Property

Sample Point	Sample Designator	Sample Type	Chemical Analyses
			VOCs
33MW2S	GW4		X
33MW2	GW4		X
33MW3	GW4		X
33MW4S	GW4		X
33MW4	GW4		X
33MW6D	GW4		X
33MW7S	GW4		X
33MW7D	GW4		X
33MW10S	GW4		X
33MW10D	GW4		X
	GW4D	Field Duplicate	X
33MW11S	GW4		X
33MW11D	GW4		X
33MW13S	GW4		X
	GW4MS	Matrix Spike	X
	GW4MSD	Matrix Spike Duplicate	X
33MW13D	GW4		X
33MW15S	GW4		X
33MW15D	GW4		X
33MW16S	GW4		X
33MW16D	GW4		X
Trip Blanks			
TB	Date-Day 1	Trip Blank	X
TB	Date-Day 2	Trip Blank	X
TB	Date-Day 3	Trip Blank	X
TB	Date-Day 4	Trip Blank	X

Notes:

- Locations shown for QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, etc.
- An explanation of the sample naming/numbering nomenclature is provided in Section II-3.11 of the RFI Workplan.

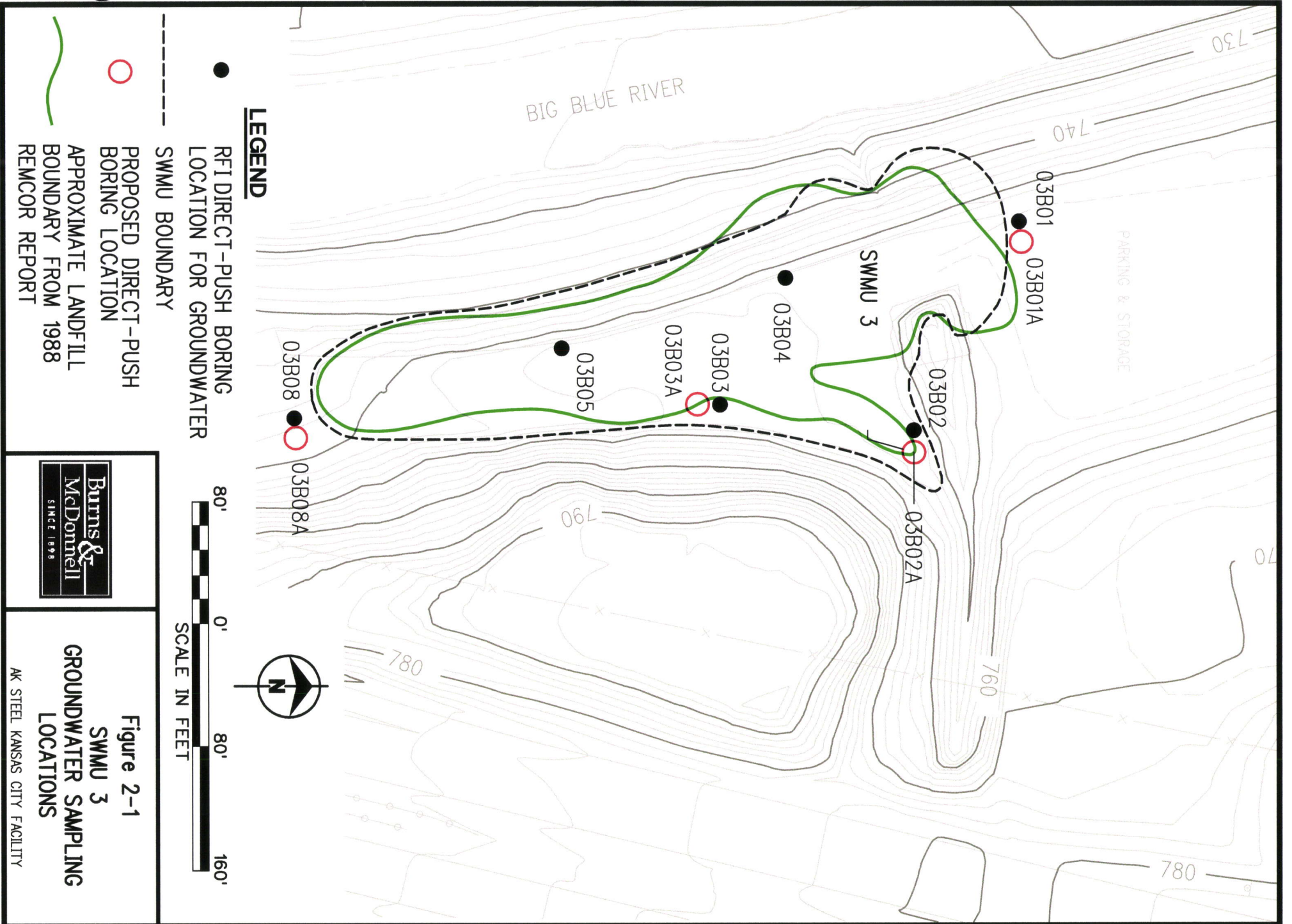
VOCs - Volatile Organic Compounds

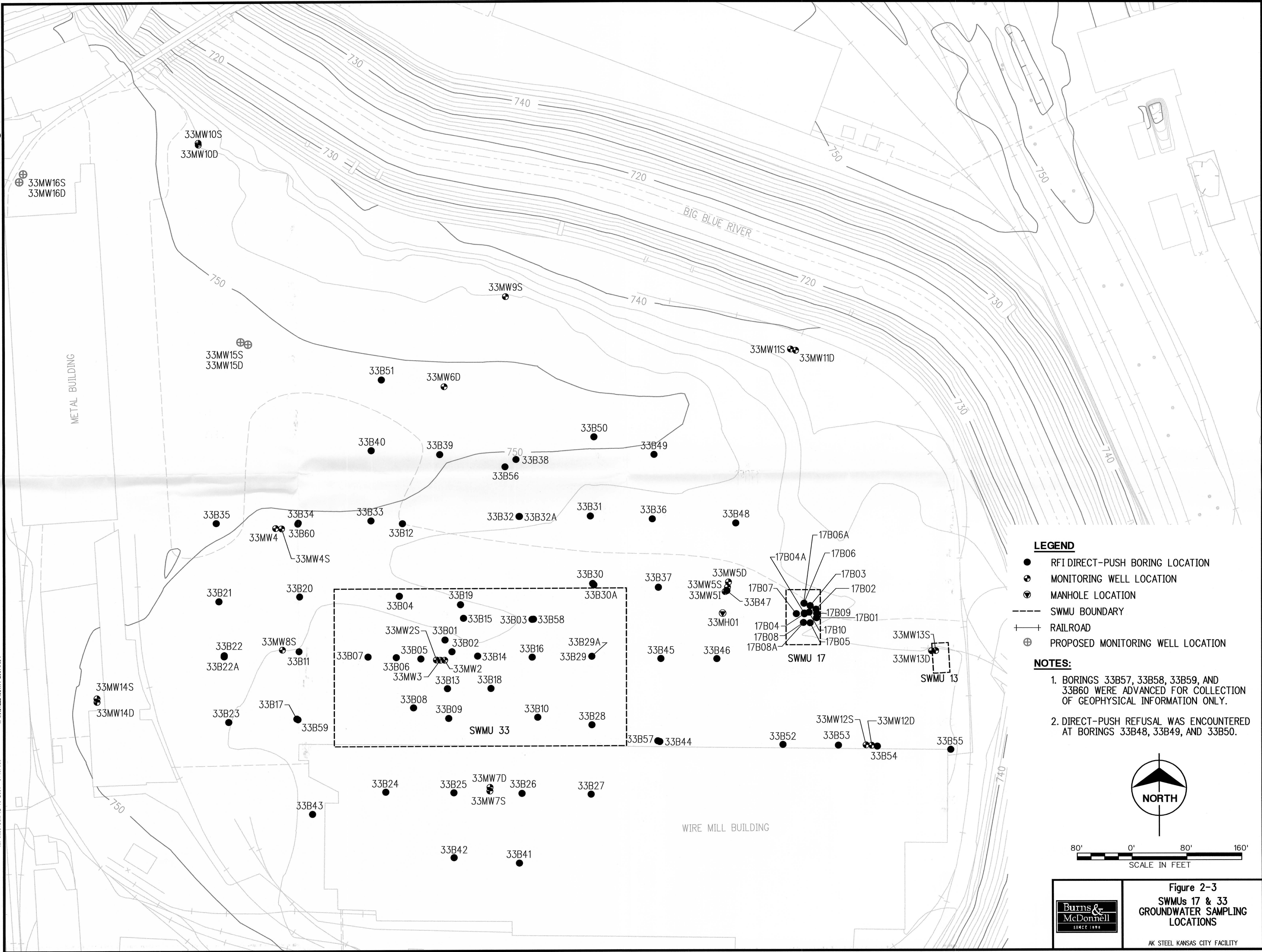
Table 2-6
AOC 8 - "Owl Gun Club" Shooting Park
Subsurface Soil Samples
 AK Steel Kansas City Facility
 AK Steel Property

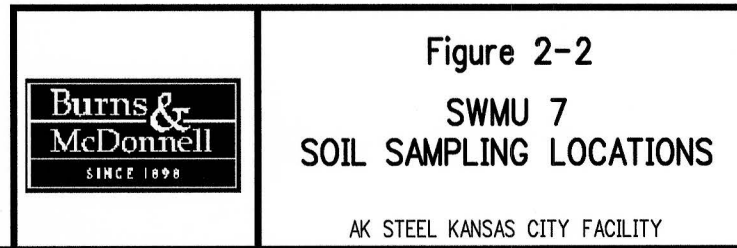
Sample Point	Sample Designator	Sample Type	Estimated Depth of Sample (ft)	Chemical Analysis
				Lead
A08B01A*	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B12A*	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B18A*	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B26A*	SB1		0 - 0.5	X
	SB1D	Field Duplicate	0 - 0.5	X
	SB2		0.5 - 2	X
A08B38A*	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B49	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
	SB2MS	Matrix Spike	0.5 - 2	X
	SB2MSD	Matrix Spike Duplicate	0.5 - 2	X
A08B50	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B51	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
A08B52	SB1		0 - 0.5	X
	SB2		0.5 - 2	X
	SB2R	Equipment Rinsate	--	X

Notes:

- * - Borings will be placed at the approximate locations of the RFI borings.
- Locations shown for QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, etc.
- An explanation of the sample naming/numbering nomenclature is provided in Section II-3.11 of the RFI Workplan.







3.0 CORRECTIVE MEASURES ALTERNATIVES

The purpose of Section 3.0 is to identify and evaluate potential remedial alternatives for contaminated soil and groundwater identified and characterized during the RFI. The initial step in the evaluation process consists of the identification of potentially applicable technologies that may be utilized for the management, containment, treatment, stabilization, and/or disposal of contaminated materials. The technologies selected for preliminary screening represent a wide range of responses commonly used to address groundwater and soil contamination. Information on each technology is presented in tabular format in Section 3.1.

Potential remedial alternatives will be evaluated in detail in the CMS Report for specific SWMUs and AOCs. The criteria utilized in the CMS Report to evaluate the potential remedial alternatives are documented in Section 4.0. The goal of the evaluation process is to choose remedies that are protective of human health and the environment, economically feasible, readily implementable, and provide rapid site restoration. The criteria utilized are consistent to those presented in the *RCRA Corrective Action Plan* (USEPA, 1994).

3.1 IDENTIFICATION OF POTENTIALLY APPLICABLE TECHNOLOGIES

The first step in developing a recommendation for corrective measures is to identify technologies that may be used to remediate contaminants of concern under the conditions present at the Facility. Tables 3-1 through 3-5 present a wide range for technologies commonly used in the environmental field to remediate soil and groundwater contamination. The technologies were grouped into six distinct subsets based on their potential application at the Facility. The remedial subsets are: "no action" (Table 3-1), source control (Table 3-2), ex-situ soil treatment (Table 3-3), in-situ soil treatment (Table 3-4), and groundwater treatment (Table 3-5) technologies. A brief description of each technology is provided in the tables. General comments regarding the potential effectiveness and implementability of each technology are also provided as part of the screening process. Relative unit costs were included; however, these costs will vary significantly from site-to-site and were used as a preliminary indication of the financial resources required to implement each technology. A comments column was provided to document any relevant information not covered under the description, effectiveness, implementability, or relative cost headings.

3.1.1 "No Action" Technologies

3.1.1.1 Monitoring Programs

Groundwater and surface water monitoring is recommended near areas having the potential to endanger human health and the environment. A long-term groundwater monitoring and analysis program may be used to identify changes in groundwater flow patterns, contaminant levels, and to track contaminant plume migration. In the absence of remedial action, monitoring will not reduce the contaminant migration, nor prevent contaminant levels from increasing. However, monitoring provides an effective method to assess the potential impact of contaminants on identified receptors. Given time, natural subsurface processes, such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials will reduce contaminant concentrations in the subsurface.

3.1.1.2 Access Control

Access control restrictions have been implemented at the Facility. Access at the Facility is currently controlled by perimeter fencing and guarded gates. These controls will be maintained in the foreseeable future. These controls are existing and maintained for public safety regardless of remedial success at the Facility. Access control is not a permanent solution to long-term concerns associated with the contamination at the Facility. Access control in the eastern portion of the Facility to SWMUs and AOCs near these water bodies could be a component of the recommended remedial approach.

3.1.1.3 Land and Groundwater Use Restrictions

Groundwater and land use restrictions can be utilized to prevent the installation of groundwater supply wells in contaminated aquifers at the Facility and excavation into areas with soil contamination. Implementation of groundwater or land use restrictions does not physically alter conditions at the site or reduce the volume, toxicity, or mobility of contaminants of concern. Groundwater and land use restrictions will further limit potential human exposure to contaminants detected in the groundwater or soil. Groundwater or land use restrictions will likely be recommended at SWMUs or AOCs requiring remedial action. Since the impacted groundwater is not used and alternative water supply sources are available, the restriction on groundwater use will not adversely impact neighboring properties. Deed notices and restrictions may be filed with the County Clerk to implement this technology.

3.1.2 Source Control Technologies

3.1.2.1 Constructed Barriers

To minimize the migration of groundwater contamination, a vertical barrier can be installed into the subsurface. Examples of constructed barriers include: slurry walls, grout curtains, sheet piling, and synthetic sheeting. The effectiveness of the barrier is dependent upon the barrier's permeability, resistance to deterioration, and imperfections. Barriers are most favorable when groundwater is less than 20 feet bgs and an aquitard is within 40 feet of the ground surface. Sheet piling is in place along the paved portion of the Blue River in the SWMU 33 area.

3.1.2.2 Caps

Surface capping provides a physical barrier that is effective in minimizing the potential direct exposure of humans and the environment to contaminants. Surface barriers also limits surface water infiltration, thereby reducing the long-term mobility of contaminants beneath the caps. Surface caps are already in place at SWMUs 2, 3, and 5.

3.1.2.3 Surface Contouring

Surface contouring is also considered a feasible technology for SWMUs and AOCs at the Facility. Surface contouring has already been performed for SWMUs 2, 3, and 5. At these SWMUs, surface grading and contouring directs surface water runoff to minimize infiltration. Well-maintained features are effective at intercepting, diverting, and routing surface water away from contaminated areas.

3.1.3 Ex-Situ Soil Treatment Technologies

3.1.3.1 Biological Treatment

Biological treatment is effective for the remediation of nonchlorinated VOCs, but requires an anaerobic system for the treatment of chlorinated VOCs. Soils are excavated and placed within a treatment cell or unit. The water content and nutrient levels are adjusted to optimize biodegradation. Biological treatment is not applicable for the treatment of inorganic constituents.

3.1.3.2 Thermal Treatment

Thermal treatment is effective for the remediation of organic compounds. Soils are excavated and heated (200 to 600 °C) either on- or off-site. Rotary dryer and thermal screws are common types of thermal treatment units. Due to the vapor residuals, thermal treatment may require air permitting. Thermal treatment is not applicable for the treatment of inorganic constituents.

3.1.3.3 Solidification/Stabilization

Solidification/stabilization reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. Leachability testing is typically performed to measure the immobilization of contaminants. For ex-situ solidification/stabilization, soil is excavated and mixed with cement or a similar agent. Solidification/stabilization is generally effective for the treatment of metals and SVOCs. It is generally not recommended for sludge or extremely oily soils.

3.1.3.4 Off-Site Landfilling

Off-site disposal of contaminated soils in a permitted landfill is a feasible remedial technology. The technology is utilized extensively in hazardous waste site remediation and is effective for the contaminants found at the Facility. During excavation of contaminated soil, dust and vapor control provisions would be implemented to protect on-site workers and the environment from vapor and fugitive dust emissions. Materials excavated from the Facility that were contaminated with VOCs, SVOCs, and metals classified as hazardous have been historically disposed at RCRA Subtitle C landfills. Waste transported to the landfill must meet federal and state shipping, manifesting, and land disposal restriction regulations. The volume and characteristics of the waste requiring excavation and disposal are the primary factors determining implementability and cost.

3.1.3.5 Soil Washing and Acid Extraction

Soil washing and acid extraction are selected as feasible treatment methods for the removal of lead shot from soil. Soil washing uses physical separation to remove particulate matter from soil. Acid washing furthers the process using chemical extraction to remove material too small for physical separation. Both technologies are well-demonstrated and effective for lead shot removal. Effectiveness can be reduced by silts and clay soils. Pilot tests would likely be needed to determine effectiveness in AOC 8 soils.

3.1.4 In-Situ Soil Treatment Technologies

3.1.4.1 Electrokinetic Separation

Electrokinetic separation (ES) uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics. It is primarily a separation and removal technique for contaminants from soils. The principle of ES relies upon application of a low-intensity direct current through the soil between ceramic electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes. Metal ions, ammonium ions, and

positively charged organic compounds move toward the cathode. Anions such as chloride, cyanide, fluoride, nitrate, and negatively charged organic compounds move toward the anode. Targeted contaminants for electrokinetics are heavy metals, anions, and polar organics in soil, mud, sludge, and marine dredge. Concentrations that can be treated range from a few parts per million (ppm) to tens of thousands ppm. Electrokinetics is most effective in clays because of the negative surface charge of clay particles.

3.1.4.2 Soil Vapor Extraction

Soil vapor extraction (SVE) is an in situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on air discharge regulations. The target contaminant groups for in situ SVE are VOCs and some fuels. The technology is typically applicable only to volatile compounds with a Henry's law constant greater than 0.01 or a vapor pressure greater than 0.5 mm Hg (0.02 inches Hg). Other factors, such as the moisture content, organic content, and air permeability of the soil, will also affect in situ SVE's effectiveness. Soil that has a high percentage of fines and a high degree of saturation will require higher vacuums (increasing costs) and/or hindering the operation of the in situ SVE system.

3.1.4.3 Solidification/Stabilization

Solidification/stabilization reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. Leachability testing is typically performed to measure the immobilization of contaminants. Soil is treated in-place. Solidification/stabilization is generally effective for the treatment of metals and SVOCs. It is generally not recommended for sludge or extremely oily soils.

3.1.4.4 Enhanced Soil Vapor Extraction

Thermally enhanced SVE is a full-scale technology that uses electrical resistance / electromagnetic / fiber optic / radio frequency heating or hot-air/steam injection to increase the volatilization rate of semi-volatiles and facilitate extraction. The process is otherwise similar to standard SVE (Section 3.1.4.2), but requires heat resistant extraction wells. Thermally enhanced SVE is normally a short- to medium-term technology.

3.1.4.5 Chemical Oxidation-Reduction

Discussion of chemical oxidation-reduction is presented in Section 3.1.5 (Groundwater Treatment Technologies).

3.1.5 Groundwater Treatment Technologies

3.1.5.1 Groundwater Recovery Wells

Wells can be used effectively to alter hydraulic gradients and remove groundwater from the subsurface for treatment. Wells can be installed vertically, inclined, or horizontally to address the groundwater plume. The liquid residual that is produced can be treated in a number of ways (biological treatment, air stripping, activated carbon, etc.).

3.1.5.2 Natural Attenuation

Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels. Consideration of this option usually requires modeling and evaluation of contaminant degradation rates and pathways and predicting contaminant concentration at down gradient receptor points, especially when the plume is still expanding/migrating. In addition, long term monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives. Target contaminants for natural attenuation are VOCs, SVOCs, and fuel hydrocarbons.

3.1.5.3 Chemical Oxidation-Reduction

Chemical injection and permeable chemical treatment walls are two broad categories of in situ chemical oxidation-reduction and/or bioaugmentation techniques. Discussion of permeable chemical treatment walls is presented in Section 3.1.5.6. In the chemical injection process, oxidizing compounds are introduced to contaminated zones to facilitate the complete breakdown VOCs, especially chlorinated solvents. Several oxidants have been employed for this purpose; however, the most common ones used for remediation of chlorinated solvents are hydrogen peroxide in combination with ferrous iron (i.e., Fenton's reagent) and potassium permanganate.

Fenton's reagent results in degradation without the formation of intermediate daughter products. The materials are relatively inexpensive and non-toxic. However, low pH conditions are required for optimized use of Fenton's reagent, and control of in-situ heat and gas produced during application of Fenton's reagent can be problematic. Potassium permanganate operates over a wider range pH range than

Fenton's reagent, is generally more stable than Fenton's reagent and is less costly. However, increased manganese concentrations in the subsurface are a potential regulatory concern. In addition, groundwater can become stained purple from unreacted permanganate. Both oxidants have the potential to produce particulates during the reaction that can reduce permeability in fine-grained materials.

Another type of chemical has been used to enhance (or augment) bioremediation and reductive dechlorination. Formulation such as Hydrogen Release Compound (HRC®) have been used to initiate reductive degradation of chlorinated solvents in groundwater and soil at a variety of sites. HRC is a polylactate ester that slowly releases lactic acid upon hydration. The lactic acid is then utilized by indigenous bacteria to produce hydrogen, which reacts to degrade chlorinated solvents. Bioaugmentation can be limited by clogging of injection wells with microbial colonies, which can severely limit preferential flow paths. Bioaugmentation methods are generally not suited for clay, highly layered, or heterogeneous subsurface environments. High concentrations of heavy metals, highly chlorinated organic compounds, long chain hydrocarbons, or inorganic salts can also be toxic to microorganisms.

3.1.5.4 Air Sparging

Air sparging is an in situ technology in which air is injected through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants. The injected air helps to flush (bubble) the contaminants up into the unsaturated zone where a vapor extraction system removes the generated vapor phase contamination. This technology is designed to operate at high flow rates to maintain increased contact between ground water and soil and to strip more ground water by sparging. Oxygen added to contaminated ground water and vadose zone soils can enhance biodegradation of contaminants below and above the water table. The target contaminant groups for air sparging are VOCs and fuels.

3.1.5.5 Hydrofracturing

Hydrofracturing is a pilot-scale technology in which pressurized water is injected to increase the permeability of consolidated material or relatively impermeable unconsolidated material. Fissures created in the process are filled with a porous medium that can facilitate bioremediation and/or improve extraction efficiency. Fractures promote more uniform delivery of treatment fluids and accelerated extraction of mobilized contaminants. Typical applications are linked with soil vapor extraction, in situ bioremediation, and pump-and-treat systems. Hydrofracturing is applicable to a wide range of

contaminant groups with no particular target group. The potential exists to open new pathways leading to the unwanted spread of contaminants.

3.1.5.6 Passive/Reactive Treatment Walls

A permeable reaction wall is installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as zero-valent metals, chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others. The contaminants will either be degraded or retained in a concentrated form by the barrier material. Target contaminant groups for passive treatment walls are VOCs, SVOCs, and inorganics.

Modifications to the basic passive treatment walls may involve a funnel-and-gate system or an iron treatment wall. The funnel-and-gate system for in situ treatment of contaminated plumes consists of low hydraulic conductivity cutoff walls (the funnel) with a gate that contains in situ reaction zones. Ground water primarily flows through high conductivity gaps (the gates). The type of cutoff walls most likely to be used in the current practice are slurry walls or sheet piles. An iron treatment wall consists of iron granules or other iron bearing minerals for the treatment of chlorinated contaminants such as TCE, DCE, and vinyl chloride. As the iron is oxidized, a chlorine atom is removed from the compound by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The iron granules are dissolved by the process, but the metal disappears so slowly that the remediation barriers can be expected to remain effective for many years, possibly even decades. Passive treatment walls are generally intended for long-term operation to control migration of contaminants in ground water.

3.1.5.7 Fluid Vapor Extraction

Fluid/vapor extraction can be used to remediate VOCs in soil and ground water. A high vacuum system is applied to remove liquid and gas from low permeability or heterogeneous formations. The vacuum extraction well is screened section in the zone of contaminated soils and ground water. The system lowers the water table around the well, exposing more of the formation. Contaminants in the newly exposed vadose zone are then accessible to vapor extraction. Because of the turbulence created during extraction, most of the contaminants in the water are stripped away, and little additional treatment is needed. It is more effective than SVE for heterogeneous clays and fine sands.

3.2 SWMU/AOC REMEDIAL ALTERNATIVES

3.2.1 SWMUs 2, 3, and 5 - Landfills

SWMUs 2, 3 and 5 are capped landfills. The following alternatives may be evaluated in the CMS Report for each of these landfills:

- Access Control
- Cap and Surface Contouring Maintenance
- Land Use and Groundwater Use Restrictions
- Groundwater Monitoring

3.2.2 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tank

Lead and cadmium in soil associated with electric-arc furnace dust are the primary concern for SWMU 7.

The following alternatives may be evaluated in the CMS Report for SWMU 7:

- Access Control
- Land Use Restrictions
- Capping and Surface Contouring
- In-situ and ex-situ Solidification/Stabilization of soil
- Excavation and off-site disposal of soil
- Groundwater Monitoring

3.2.3 AOC 8 – “Owl Gun Club” Shooting Park

Lead in soil associated with lead shot is the primary concern for AOC 8. The following alternatives will be evaluated in the CMS Report for AOC 8:

- Access Control
- Land Use Restrictions
- Capping and Surface Contouring
- In-situ and ex-situ Solidification/Stabilization of soil
- Soil Washing
- Acid Extraction and Metals Recovery
- Excavation and off-site disposal of soil
- Groundwater Monitoring

3.2.4 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area

Chlorinated VOCs in soil and groundwater associated with degreasing operations using chlorinated solvents are the primary concern at SWMUs 17 and 33. Metals in groundwater are a lesser concern at SWMU 17. The following alternatives may be evaluated in the CMS Report for SWMUs 17 and 33.

- Access Control
- Land Use and Groundwater Use Restrictions
- Groundwater Monitoring
- Biological or Thermal Treatment of Soil
- Electrokinetic Separation of Soil
- Soil Vapor Extraction and Enhanced Soil Vapor Extraction
- Groundwater Recovery Wells
- Natural Attenuation
- Chemical Oxidation-Reduction
- Constructed Barriers (Passive and/or Reactive Treatment Walls) for Groundwater
- Air Sparging
- Hydrofracturing
- Fluid vapor extraction of soil and groundwater

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Table 3-1
Identification of Potentially Applicable "No Action" Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Groundwater Monitoring	Wells screened in the shallow and deep groundwater aquifer zones.	Dependent on number of wells and location. Proper field sampling procedures and analytical protocol are required.	May require installation of additional wells.	Dependent on the number of wells, construction materials, frequency of sampling, and types of analyses performed.	
Surface Water Monitoring	Surface water samples collected and analyzed from the Blue River and Rock Creek.	Dependent on frequency and location. Proper field sampling procedures and analytical protocol are required.	Implementation relatively easy.	Dependent on the number of samples collected, frequency of sampling, and types of analyses performed.	
Access Control	Prevents individuals from inadvertently coming in contact with areas containing contamination. May include surveillance systems, artificial or natural barriers, entry control and signs.	Dependent on maintenance of boundaries and proper training of security force.	Currently implemented at the site	Access control is currently being implemented and financed under existing operations.	
Land Use Restrictions	Deed notice and deed restrictions filed with County Clerk. Prohibits residential development at the site.	Dependent on enforcement vehicle. Continued environmental monitoring is required.	Administrative effort is required to draft deed restriction and file with county.	AK Steel administrative staff can be utilized. County recording fee is low.	Site currently zoned heavy industrial.
Groundwater Use Restrictions	Deed notice and deed restrictions filed with County Clerk. Prohibits development of contaminated aquifers at the site.	Dependent on enforcement vehicle. Continued environmental monitoring is required. Only appropriate for Class II and Class III aquifers.	Administrative effort is required to draft deed restriction and file with county.	AK Steel administrative staff can be utilized. County recording fee is low.	The aquifer underlying the Facility is not currently utilized as a source of water.

Table 3-2
Identification of Potentially Applicable Source Control Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Constructed Barriers	A vertical barrier is installed in the subsurface to minimize migration of groundwater contamination off-site. Examples: Bentonite and cement slurry walls, grout curtain, sheet piling, synthetic sheeting. May need low volume pump and treat to control.	Dependent upon barrier's permeability, resistance to deterioration, and imperfections.	Most favorable when groundwater < 20 feet and aquitard within 40 feet of ground surface. Sheet piling is in place along the Blue River in the SWMUs 17 and 33 area.	Moderate to high depending on depth and material. \$8 to \$12/ft ² .	Unfavorable for highly reactive contaminants and in expansive soils.
Cap	Soil liner and flexible membrane liner utilized to limit infiltration, promote efficient drainage and prevent direct contact of contaminants with potential receptors.	Contingent on regular maintenance.	Construction is performed using common construction equipment. SWMUs 2, 3, and 5 are capped landfills.	Low to moderate; \$25 to \$30/yd ²	Requires long-term monitoring. Can be used to enhance soil vapor extraction technology efficiency.
Surface Contouring	Surface grading/contouring directs surface water runoff to minimize infiltration. Construction of drainage swales, berms, and/or ditches are examples.	Well maintained features are effective at intercepting, diverting, and routing surface water away from contaminated areas.	Construction is performed using common construction equipment. SWMUs 2, 3, and 5 are contoured.	Low to moderate; \$0.40 to \$3.00/yd ³	

Table 3-3
Identification of Potentially Applicable Ex-Situ Soil Treatment Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Biological Treatment	Soils are excavated and placed in a treatment cell or unit. Water content and nutrient levels are adjusted to optimize biodegradation and monitored. Soil can be treated in a slurry or berm.	Aerobic treatment is effective for the treatment of BTEX and TPH. Anaerobic treatment is required for treatment of halogenated compounds.	Bench and pilot-treatability studies are needed. Remediation enhanced at temperatures >40 F.	Moderate; \$50 to \$300/ton. O&M and capital intensive.	Not applicable for treatment of inorganics.
Thermal Treatment	Soil is excavated and thermally treated (200 to 600 F) on- or off-site. Rotary dryer and thermal screw are two thermal units commonly used.	Very effective for the treatment of organics. Not applicable for inorganics. Moisture content may need to be reduced before treatment.	May require permitting. Heavy metals may cause problems.	Moderate; \$40 to \$100/ton. O&M and capital intensive.	Vapor residuals produced. Not effective in high-clay content soils.
Solidification/Stabilization	Excavated soil is mixed with cement or similar agent. Chemical may be added to help bind pollutants in matrix, reducing their mobility.	Generally effective for metals and SVOCs. Soil may require pretreatment for VOCs. Generally not recommended for sludges or extremely oily soils.	Technology is offered by numerous vendors. Bench or pilot-tests are needed. Off-site disposal of solid residuals is common.	Moderate; \$100 to \$200/ton. Capital intensive.	Unfavorable in high-clay or debris content soils.
Off-site Landfilling	Contaminated material is removed and transported to a permitted treatment and disposal facility.	Waste may require treatment to meet land disposal restrictions (LDRs). Effectiveness is dependent on long-term management of disposed wastes.	Approval from regulatory agency is required.	High; \$250 to \$500/ton.	Concern regarding long-term liabilities.
Soil Washing	Soil is excavated and mechanically scrubbed to separate the soil fractions.	Effectively cleans sand and other coarse soil fragments. Removes lead pellets. Silts and clays are harder to treat. Removal effectiveness only 50 to 90% removal.	Technology is well demonstrated and offered by numerous vendors. Pilot tests are needed.	Low to moderate; \$30 to \$100/ton.	Useful only for particulate contamination (i.e., lead shot).
Acid Extraction Metals Recovery & Recycling System	Soil is excavated and particulates (i.e., lead shot) is removed by physical separation, chemical extraction and liquids processing.	Very effective for treatment of particulate metals.	Technology is well demonstrated and offered by numerous vendors. Pilot tests are needed.	Moderate; \$100 to \$250/ton.	Useful only for particulate contamination (i.e., lead shot).

Table 3-4
Identification of Potentially Applicable In-Situ Soil Treatment Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Electrokinetic Separation	Electrokinetic separation (ES) removes metals and organic contaminants from low permeability, clayey soils. ES uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics.	Concentrations that can be treated range from a few parts per million (ppm) to tens of thousands ppm. Electrokinetics is most applicable in low permeability soils.	Technology is relatively new. Pilot treatability studies are needed. Air emissions may need regulation.	Moderate; \$45/cu.yd. Capital & O&M intensive.	Electrokinetics is most effective in clays because of the negative surface charge of clay particles.
Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to be removed from soil through extraction wells. This technology also is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.	Dependent on Henry's Law Constant of contaminant, moisture content and air permeability. The technology is effective at remediating VOCs and some fuels. Low permeability surface cap will enhance performance.	Field pilot study required. May require permitting. Pneumatic or hydrofracturing may be useful in tight soils. Not effective if groundwater < 10 feet or clay content > 20 percent.	Low to moderate; \$10 to \$40/cu.yd. Capital and O&M intensive.	Not effective for treatment of inorganics. Soil with a high percentage of fines and degree of saturation will require higher vacuum (higher cost).
Solidification/Stabilization	Solidification/stabilization (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Generally effective for metals and low levels of organics. Not effective for treatment of VOCs.	Few, if any, commercial applications to date. Pilot - scale and full-scale implementation at a number of sites.	Moderate to high; \$40 to \$60/cu.yd. for shallow applications and \$150 to \$250/cu.yd. for deeper applications	Depth of contaminants may limit some types of application processes and solidified material may hinder future site use.
Enhanced Soil Vapor Extraction	Thermally enhanced SVE is a full-scale technology that uses electrical resistance/electromagnetic/fiber optic/radio frequency heating or hot-air/steam injection to increase the volatilization rate of semi-volatiles and facilitate extraction. The process is otherwise similar to standard SVE, but requires heat resistant extraction wells.	High soil moisture content limits standard SVE. Heating, especially radio frequency heating and electrical resistance heating can improve SVE performance in high moisture soils. After application, subsurface conditions are excellent for biodegradation of residual contaminants.	Few, if any, commercial applications to date. Pilot - scale and full-scale implementation at a number of sites.	Low to moderate; \$25 to \$100/cu.yd. plus \$10K - \$100K for pilot testing. O&M intensive.	Debris or other large objects buried in the media can cause operating difficulties. Thermally enhanced SVE is not effective in the saturated zone

Table 3-4
Identification of Potentially Applicable In-Situ Soil Treatment Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Chemical Oxidation / Reduction / Bioaugmentation	Oxidizing, reducing, or bioaugmenting compounds are introduced into the subsurface, usually by chemical injection. In chlorinated solvents, carbon-chlorine bonds are attacked thereby causing degradation	Dependent on subsurface geology (reduced effectiveness in low permeability materials without fracturing, etc.).	Pilot studies are needed. May require permitting. Equipment and materials are readily available.	Moderate; \$20 to \$80/cu. yd.	Heterogeneity and low permeability may cause some soil zones to be relatively unaffected.

Table 3-5
Identification of Potentially Applicable Groundwater Treatment Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Groundwater Recovery Wells	Wells are installed vertically, inclined, or horizontally to address groundwater plume. Well diameter may vary from several inches to several feet depending upon soil or rock type.	Wells can be used effectively to alter hydraulic gradients and remove groundwater from the subsurface for treatment.	Construction utilizes conventional equipment and materials.	Low to moderate; \$20 to \$75/foot. Dependent on well orientation.	Liquid residual produced requiring treatment.
Natural Attenuation	Natural subsurface processes—such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials—are allowed to reduce contaminant concentrations to acceptable levels.	Natural attenuation is not the same as "no action," although it often is perceived as such. In CERCLA, natural attenuation is considered on a case-by-case basis; guidance on its use is still evolving.	Requires modeling / evaluation of contaminant degradation rates, pathways and concentration(s) at receptor points.	Most significant costs are associated with site characterization and performance monitoring.	Target contaminants for natural attenuation are VOCs and SVOCs. Continuous monitoring for several years until target cleanup levels are achieved
Air Sparging	In air sparging, air is injected horizontally and vertically through a contaminated aquifer to remove contaminants by volatilization. A vapor extraction system is used to collect vapors from the vadose zone for treatment.	Dependent on subsurface geology (reduced effectiveness in low permeability materials). May enhance aerobic biodegradation of contaminants. Target contaminants are VOCs and fuels.	May require permitting. Pilot studies are needed. Unfavorable in low permeability aquifers. Demonstrated at numerous sites although few are well documented.	Moderate; \$150K to \$350K/acre of groundwater plume	Soil heterogeneity may cause some zones to be relatively unaffected. Has potential to spread contamination.
Hydrofracturing	Injection of pressurized water through wells fractures low permeability and over-consolidated sediments. Cracks are filled with porous media that serve to enhance bioremediation or improve pumping efficiency.	Applicable to a wide range of contaminant groups. Can be used in conjunction with SVE to enhance recovery or to deliver fluids, substrates and nutrients for in situ bioremediation applications.	Hydrofracturing has had widespread use in the petroleum and water-well construction industries but is an innovative method for remediating hazardous waste sites.	Low to moderate; \$1K to 1.5K/fracture	Potential exists for unwanted spread of contaminants. Low permeability zones may still exist after hydrofracturing.
Passive/Reactive Treatment Walls	Permeable reaction wall across contaminant plume flow path allows water to move passively through. Contaminants are trapped by agents such as zero-valent metals, chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others.	Target contaminant groups for passive treatment walls are VOCs, SVOCs, and inorganics. Passive treatment walls are generally intended for long-term operation to control migration of contaminants in ground water.	Limited to a subsurface lithology that has a continuous aquitard at a depth that is within the vertical limits of trenching. May require permitting. Pilot studies are needed.	Complete cost data still not available because most sites are demonstration scale and are likely overdesigned for a safety margin.	Wall materials may lose their reactive capacity, requiring replacement of the reactive medium.

Table 3-5
Identification of Potentially Applicable Groundwater Treatment Technologies
 AK Steel Kansas City Facility

Technology	Description	Effectiveness	Implementability	Relative Cost	Comments
Fluid Vapor Extraction	A high vacuum system is applied to simultaneously remove liquid and gas from low permeability or heterogeneous formations. Lowers water table exposing vadose zone for more efficient SVE.	More effective than SVE for heterogeneous clays and fine sands. Typically used in vadose zone soils w/ permeability range of 10E-8 to 10E-3 cm/s.	Pilot studies are needed. May require permitting. Equipment and materials are readily available.	Moderate; \$160/pound of contaminant. O&M intensive.	One pilot-scale test result indicates 12 times greater removal rate than pump-and-treat.
Chemical Oxidation / Reduction / Bioaugmentation	Oxidizing, reducing, or bioaugmenting compounds are introduced into the subsurface, usually by chemical injection. In chlorinated solvents, carbon-chlorine bonds are attacked thereby causing degradation	Effective with favorable subsurface conditions. Dependent on subsurface geology (reduced effectiveness in low permeability materials without fracturing, etc.).	Pilot studies are needed. May require permitting. Equipment and materials are readily available.	Low to high; \$20 to \$500/ 1K gallons. O&M can be significant	Heterogeneity and low permeability may cause some soil zones to be relatively unaffected.

4.0 EVALUATION OF CORRECTIVE MEASURES

4.1 TECHNIQUE FOR EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

The purpose of a CMS is to identify and evaluate potential remedial alternatives for facilities requiring corrective action. Selection of appropriate corrective measure alternatives is based on the principle that the selected alternative is protective of human health and the environment. USEPA currently has the following expectations for corrective measures.

- Corrective measures should address the principal contamination threats posed by a site whenever practicable and cost-effective.
- Engineering controls, such as containment, for contaminated media are acceptable as corrective measures so long as minimal long-term threat to human health and the environment and remedial impracticability, are demonstrated.
- Active remediation, engineering controls, and institutional controls can be utilized concurrently at a site so long as human health and the environment are protected.
- Institutional controls, while useful in combination with engineering controls and active remediation, should not generally be used as the sole corrective measure for a site.
- Innovative remedial technologies should be favored over conventional remedial technologies as corrective measures when advantages of superior treatment or implementability, less adverse impact, or lower overall costs can be realized.
- Groundwater should be restored to its maximum beneficial usage wherever practicable within a reasonable, site-specific timeframe. Where groundwater restoration is not practicable, prevention or minimization of further groundwater plume migration; prevention of groundwater exposure to humans or the environment; and additional risk reduction evaluation, is necessary. Surface and/or subsurface sources of groundwater contamination should be controlled or eliminated.

- Corrective measures should be implemented on contaminated soils as necessary to prevent or limit direct exposure to human or environmental receptors and prevent transfer of unacceptable levels of contamination to other media via leaching, runoff, or airborne emissions.

4.2 DECISION MAKING PROCESS FOR CORRECTIVE MEASURE ALTERNATIVES

Evaluation of corrective measures will utilize the method first proposed by USEPA for the RCRA Corrective Action Program in 1990 and updated in the 1996 Proposed Rule on Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities (FR, 1996). The USEPA has established a two-phased evaluation process for corrective measures evaluation and selection. During the first phase, potential remedial alternatives are screened to determine whether they meet four threshold criteria. Those remedies that meet all four threshold criteria are then re-examined during a second evaluation phase using five balancing criteria to identify which corrective measure is best suited to a specific situation.

The four threshold criteria that potential remedial alternatives must achieve to be given further consideration include:

- Protection of human health and the environment
- Attainment of media cleanup standards
- Control source of release
- Compliance with applicable standards for waste management

The five balancing criteria include:

- Long-term reliability and effectiveness
- Reduction of toxicity, mobility, or volume of wastes
- Short-term effectiveness
- Implementability
- Economic Feasibility

Corrective measures will be evaluated according to the threshold criteria. The relative merits of each alternative meeting the threshold criteria will be evaluated in relation to each of the balancing criteria. The criteria utilized for evaluation of each alternative are described in the following sections. The advantages and disadvantages of each alternative relative to one another will be identified. The

comparative analysis of the alternatives will be presented in a narrative discussion or tables and will include a description of the following:

- Strengths and weaknesses of the alternatives relative to one another with respect to each balancing criterion
- Sensitivity of expected performance to reasonable variation of key uncertainties
- Differences between the alternatives (qualitative or quantitative)
- Substantive differences among the alternatives
- A description of potential advantages of an alternative in cost or performance, and the degree of certainty of these associated with each

4.2.1 Protection of Human Health and the Environment

Corrective action remedies must be protective of human health and the environment. Each alternative is evaluated on its potential to prevent exposure risk to human and the environment during and after remedial action is initiated. Technologies posing the least short- and long-term risk to human health and environment are the most desirable for remedial activities. Risks associated with source control and management of wastes generated during remedial actions are also considered in the evaluation. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	No risk to human health and the environment.
	Good	More protective than risk criteria.
	Adequate	Meets risk criteria.
UNFEASIBLE	Exceeds human health and environmental risk criteria.	

4.2.2 Attainment of Media Cleanup Standards

A risk evaluation was utilized to develop media cleanup standards, contaminant concentrations that do not pose unacceptable risks to human health and the environment. Remedial alternatives are evaluated based on their ability to meet media cleanup standards at the point of compliance in an expeditious time

frame. Local geologic and waste characteristics are evaluated to determine if corrective action alternatives were capable of attaining media cleanup standards. When possible, each potential alternative's effectiveness is evaluated by comparing the estimated effectiveness of other alternatives with case histories conducted in similar environments. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Remediation achieves background concentrations.
	Good	Cleanup exceeds media cleanup standards.
	Adequate	Meets media cleanup standards.
UNFEASIBLE	Unable to meet media cleanup standards.	

4.2.3 Control Source of Release

Remedial alternatives must be able to mitigate environmental degradation by controlling or eliminating future releases posing threat to human health or the environment. Source control strategies should offer both short- and long-term effectiveness at a particular SWMU or AOC. In evaluating the potential long-term effectiveness of source control alternatives, remedial alternatives providing waste treatment or destruction are preferable over alternatives relying on containment systems to prevent future releases. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Elimination of potential sources of contamination.
	Adequate	Management of potential sources of contamination.
UNFEASIBLE	Releases of contamination from source area are not controlled, potentially allowing risks to human health or the environment to increase in the future.	

4.2.4 Compliance with Applicable Standards for Waste Management

Remedial activities must be conducted in compliance with local, state, and federal regulations. Regulations were identified during the evaluation process potentially relating to each remedial alternative. Remedial alternatives unable to comply with applicable regulations are not considered feasible. The final determination of applicable technologies is subject to review and approval by USEPA and MDNR. The following table gives guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Exceeds regulatory requirements.
	Adequate	Compliant with regulatory requirements.
UNFEASIBLE	Unable to meet media applicable requirements for the SWMU or remedial program.	

4.2.5 Long-Term Reliability and Effectiveness

The long-term reliability and effectiveness criterion evaluates the ability of an alternative to prevent or minimize substantial danger to public health and the environment after the alternative has been implemented. Long-term reliability and effectiveness is evaluated for each alternative or combination of alternatives. The demonstrated effectiveness of selected remedial alternative(s) under analogous site conditions was considered in evaluating whether the alternative could be used effectively. The ability of an alternative to protect potential receptors during the failure of any one technology or uncontrollable changes at the site are considered. The estimated useful life of each alternative is also considered an important factor in evaluating long-term reliability. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Eliminates threat to human health. Remedial actions are permanent and require no long-term maintenance.
	Good	Minimizes further contaminant migration and threat to human health. Major technologies are permanent, and other components continue to perform unattended with minimal maintenance.
	Adequate	Adequately protects human health by reducing contaminant releases. Overall remedial option may require regular maintenance.
	Poor	Provides for limited protection of human health by reducing the potential for exposure to contaminants. The long-term effectiveness is dependent upon maintenance.
UNFEASIBLE	Provides no protection to human health or the environment. After implementation, human or ecological receptors are exposed to elevated concentrations of harmful compounds. Remedial option may require frequent and extensive maintenance. Useful life of remediation equipment and processes may be less than restoration time frame.	

4.2.6 Reduction of Toxicity, Mobility, or Volume

Remedial alternatives that minimize risk by reducing the toxicity, mobility, or volume of waste residuals are expected to provide the greatest long-term protection to human health and the environment. Permanent reduction of the waste's toxicity, mobility, or volume is the most desirable method of minimizing long-term risks. This criterion is evaluated by comparing initial site conditions to expected post-corrective measure conditions. Recommended alternatives are chosen based on their expected effectiveness in reducing the toxicity, mobility, or volume of wastes found at each SWMU or AOC. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Elimination of toxicity, mobility, or volume of hazardous constituents with no generation of hazardous residuals.
	Adequate	Acceptable reduction of toxicity, mobility, or volume of primary hazardous constituents with manageable residuals
UNFEASIBLE	No reduction in toxicity, volume, or mobility of hazardous constituents is provided. Exposure risk is not significantly reduced.	

4.2.7 Short-Term Effectiveness

Short-term effectiveness evaluates alternatives with respect to their effects on human health and the environment during implementation of the remedial action. Risks associated with the containment, treatment, excavation, transportation, or redispal of waste materials are considered in the evaluation process. The objective is to minimize the risk to the community, workers, and the environment prior to, during, and after remediation. Remedial alternatives providing rapid restoration of the impacted area without adverse impact on workers, the community, or the environment are preferred. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	The implementation period is short and the proposed remedial activities pose no risk to the community, workers, or environment.
	Good	Potential for waste exposures during implementation is low. Implementation poses limited risk to the community, although workers may be required to use personal protective equipment to prevent intake. Releases during implementation, if any, would be minor. Potential releases would have minimal impact on the environment.
	Adequate	Potential for waste exposure during implementation is low. Implementation poses limited risk to community and workers are required to use personal protective equipment to prevent intake. Releases during implementation are anticipated but will be controlled to limit potential adverse environmental or health impacts. The proposed remediation is expected to achieve desired results in 2 to 10 years.
	Poor	Exposure to waste constituents during implementation is likely. Releases would be monitored and controlled; however, implementation may have limited effects on the community from releases of concentrations above threshold limits. Workers are required to use personal protective equipment to prevent intake. Releases could result in limited unacceptable impact on the environment.
UNFEASIBLE	Exposure to waste constituents during implementation is likely. Implementation may create unpredictable adverse effects on the community or unacceptable/uncontrolled damage to the environment from releases of chemicals above threshold limits. Implementation is expected to require more than 30 years to reach cleanup goals.	

4.2.8 Implementability

Implementability addresses the technical and administrative feasibility of initiating an alternative, and the availability of various services and materials required. Technical feasibility considers the ease of construction and operation of a particular alternative, the potential for technical problems during implementation, the ease of undertaking additional remedial action in the future, and the ability to monitor the effectiveness of the proposed alternative. Administrative implementability refers to administrative requirements that may be requested by various regulatory agencies. An alternative to be initiated expeditiously with minimal effort is most desirable. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	No implementability concerns.
	Good	May be implemented with minor technical concerns.
	Adequate	Implementation is possible, but administrative, technical, and regulatory issues prevent rapid implementation of the alternative.
	Poor	Technical, administrative, and/or regulatory issues, makes implementation of remedial alternative difficult.
UNFEASIBLE	Technical, administrative, or availability issues prohibit implementation.	

4.2.9 Economic Feasibility

Economic feasibility may be used to choose between several alternatives offering similar protection of human health and the environment. Capital and annual operation and maintenance costs are used in the evaluation of alternatives. The present worth of an alternative is the primary dollar figure used for comparative cost evaluation. The following table gives general guidelines for assessing alternatives from ideal to unfeasible:

FEASIBLE	Ideal	Limited financial obligation.
	Good	Relatively less costly than other alternatives.
	Adequate	Similar costs to other alternatives.
	Poor	Significantly more costly than other alternatives.
UNFEASIBLE	Cost prohibits implementation.	

* * * * *

5.0 PILOT, LABORATORY, AND/OR BENCH SCALE STUDIES

No pilot, laboratory, and/or bench scale studies are currently planned to assist in the evaluation of remedial alternatives for SWMUs 2, 3, 5, 7, 17, and 33 and AOC 8. However, such a study(s) may be practical for the SWMUs 7, 17, and 33 and AOC 8. Following the additional data collection activities, a decision will be made regarding the necessity of such study(s). If a pilot, laboratory, and/or bench scale study(s) is warranted, a detailed description of the proposed study(s) will be provided to USEPA and MDNR at that time.

* * * * *

6.0 CMS REPORT OUTLINE

A CMS Report will be prepared that presents an update to current conditions (including the results of additional investigation activities), media cleanup standards, and the corrective measures evaluation, including recommended corrective measures for SWMUs 2, 3, 5, 7, 17, and 33 and AOC 8. A proposed outline for the CMS Report follows.

1.0 INTRODUCTION

- 1.1 Purpose and Scope
- 1.2 Background
 - 1.2.1 Facility Location
 - 1.2.2 Facility History
 - 1.2.3 Interim Measures and RFI Tasks Completed to Date

2.0 ENVIRONMENTAL SETTING

- 2.1 Regional Geology
- 2.2 Site Geology
- 2.3 Hydrogeology
- 2.4 Ecology
- 2.5 Land and Water Uses

3.0 ESTABLISHMENT OF CORRECTIVE ACTION OBJECTIVES

- 3.1 Introduction
- 3.2 Target Media Cleanup Standards
- 3.3 Data Screening Summary

4.0 REMEDIAL ALTERNATIVE EVALUATION PROCESS

- 4.1 Introduction
- 4.2 Identification and Screening of Potentially Applicable Remedial Alternatives
- 4.3 Potential Corrective Action Alternatives
- 4.4 Screening Criteria for Potential Corrective Measures Alternatives
 - 4.4.1 Protection of Human Health and the Environment
 - 4.4.2 Attainment of Media Cleanup Standards
 - 4.4.3 Control Source of Release
 - 4.4.4 Compliance with Local, State, and Federal Regulations
 - 4.4.5 Long-Term Reliability on Effectiveness
 - 4.4.6 Reduction of Toxicity, Mobility, or Volume
 - 4.4.7 Short-Term Effectiveness
 - 4.4.8 Implementability
 - 4.4.9 Economic Feasibility
- 4.5 Recommendations

- 5.0 CORRECTIVE MEASURES ALTERNATIVES EVALUATION
 - 5.1 Introduction
 - 5.2 SWMU 2 – Old Blue River “W” Landfill
 - 5.2.1 Current Conditions Update
 - 5.2.2 Alternatives Evaluation
 - 5.2.3 Recommended Corrective Measure
 - 5.3 SWMU 3 – South of Bar Fab Landfill
 - 5.3.1 Current Conditions Update
 - 5.3.2 Alternatives Evaluation
 - 5.3.3 Recommended Corrective Measure
 - 5.4 SWMU 5 – Plant Rubble Landfill
 - 5.4.1 Current Conditions Update
 - 5.4.2 Alternatives Evaluation
 - 5.4.3 Recommended Corrective Measure
 - 5.5 SWMU 7 – No. 1 Melt Shop Baghouse Dust Tanks
 - 5.5.1 Current Conditions Update
 - 5.5.2 Alternatives Evaluation
 - 5.5.3 Recommended Corrective Measure
 - 5.6 SWMUs 17 and 33 – Wire Mill Rinsewater Neutralization Tank and Nail Mill Degreasing Area
 - 5.6.1 Current Conditions Update
 - 5.6.2 Treatability, Pilot, and/or Bench Scale Studies Update
 - 5.6.3 Alternatives Evaluation
 - 5.6.4 Recommended Corrective Measure
 - 5.7 AOC 8 – “Owl Gun Club” Shooting Park
 - 5.7.1 Current Conditions Update
 - 5.7.2 Alternatives Evaluation
 - 5.7.3 Recommended Corrective Measure
- 6.0 SUMMARY AND CONCLUSIONS
- 7.0 REFERENCES

* * * * *

7.0 PROJECT ORGANIZATION AND MANAGEMENT

7.1 ORGANIZATION

The project organization for the CMS is illustrated in Figure 7-1. Burns & McDonnell will provide CMS information to the AK Steel Project Coordinator who will be actively involved throughout the CMS. AK Steel will in turn submit information to the USEPA Region 7 Project Coordinator, as necessary. Burns & McDonnell will on occasion, and only by direction of AK Steel, have direct contact with USEPA. MDNR will also be included in project meetings or submittals as required by conditions of the Permit. The remainder of this section discusses Burns and McDonnell's project management approach.

7.1.1 Burns & McDonnell

Work conducted for the CMS will be performed by qualified Burns & McDonnell engineers, scientists, geologists, and technicians. Project responsibilities for essential personnel are as follows:

- Principal-in-Charge: Dr. Paul Hustad

The principal-in-charge has direct contact with AK Steel and overall responsibility for the successful completion of the CMS.

- Project Manager: Ms. Sharon Shelton

The project manager is responsible for adherence to project schedules; keeping the project within budget; reviewing and assessing the adequacy of performance of technical staff assigned to the project and contractors; maintaining full and orderly project documentation; communication with AK Steel regarding progress toward the project's goals; preparation of technical reports; and responsibility for quality of the product.

- Assistant Project Manager: Mr. Reynold Tomes

The assistant project manager's responsibilities are similar to those for the project manager; however, the assistant project manager will report to the project manager for all activities.

- Quality Assurance Manager: Mr. Jerry Hoffman

The quality assurance manager will be responsible for review and approval of project documents and reports for conformance to the scope of work and technical adequacy.

- Health and Safety Officer: Mr. Ken Grist
Burns & McDonnell's Health and Safety Officer will provide hazard communication information, advise employees of safe operating procedures, and advise the project manager on matters concerning the health and safety of field team members.
- Field Teams
The field teams will conduct additional investigation activities in accordance with the procedures outlined in the RFI Workplan. Qualified geologists and/or geotechnical engineers will be provided on the field teams to log borings. In addition, qualified geologists, engineers, and technicians will be provided to collect other field data. All field team personnel will have completed the 40-hour Occupational Safety and Health Administration (OSHA) training for Hazardous Waste Operations and Emergency Response (HAZWOPER) as required in 29 CFR 1910.120.
- Office Engineering
Office engineering will include data management, evaluation, interpretation, and presentation; direction and coordination of the field team(s); and report preparation.

7.1.2 Contractors

Drillers, surveyors, and laboratories with demonstrated qualifications will be hired to perform the additional data collection outlined in this CMS Work Plan. The Burns & McDonnell project manager will oversee performance of the contractors.

Several factors will be considered in the contractor selection process:

Drillers and Direct-Push Contractors

- Missouri certification, as appropriate
- Demonstrated ability and experience to accomplish the work either through satisfactory past performance for AK Steel or Burns & McDonnell or reference from other employers
- Availability of proper amount and type of equipment for satisfactory performance of the work and possible contingencies or emergencies
- Personnel with all necessary safety training and experience in hazardous waste type investigations

- Availability of equipment and crews
- Cost of services

Surveyors

- Missouri certification
- Local knowledge
- Availability of equipment and crews

Laboratories

- Demonstrated ability to do required analyses in accordance with USEPA procedures
- Ability to meet required schedules
- Availability of proper equipment and materials to perform analyses
- Implementation of documented preventive maintenance procedures and schedules
- Capable of passing an audit conducted by USEPA
- Cost of services

7.2 PROJECT SCHEDULE

The proposed schedule for the completion of the CMS at the Facility is presented in Figure 7-2. The schedule is based on the number of days elapsed from USEPA's approval of the CMS Work Plan and associated analytical laboratory submittals.

The CMS is scheduled to be completed and a report submitted to USEPA 210 days following CMS Work Plan approval. Field investigation and the subsequent need for treatability, laboratory, and/or bench-scale studies have the greatest potential for altering the project schedule. The field investigation described in Section 2.4 are estimated to take four weeks. If contamination appears to continue beyond the boundaries of the investigation areas or if other unanticipated conditions are encountered in the field, additional time may be required to complete investigation activities. Any extension to the estimated time for completion of investigation activities would extend the other items on the schedule, which follow data collection (laboratory analysis, data validation, etc.) by a similar amount of time.

Upon completion of the additional investigation activities, the data will be reviewed to determine if further investigation is needed for purposes of completing the CMS. In particular, a determination of the need for treatability, laboratory, and/or bench-scale studies will be made. If no contingent activities are

needed, completion of the CMS report will proceed according to the schedule shown on Figure 7-2. The data collected during investigation activities will be validated and analyzed. In addition to evaluation of remedial alternatives, the CMS report will include the data and its subsequent analysis. The CMS Report will be submitted to USEPA for regulatory review process as established in Section XXIII of the Permit.

If contingent activities are necessary, an interim data document will be submitted to USEPA that presents the data associated the investigation activities presented in Section 2.4, provides a preliminary assessment of the data, and proposes contingent activities. This document, if required, would be provided 210 days following CMS Work Plan approval in lieu of the CMS Report. AK Steel will submit to USEPA a time extension request with the interim data document delineating the new schedule. If appropriate, a meeting will be held with USEPA technical staff to discuss this document and agree upon the contingent CMS activities and schedule.

* * * * *

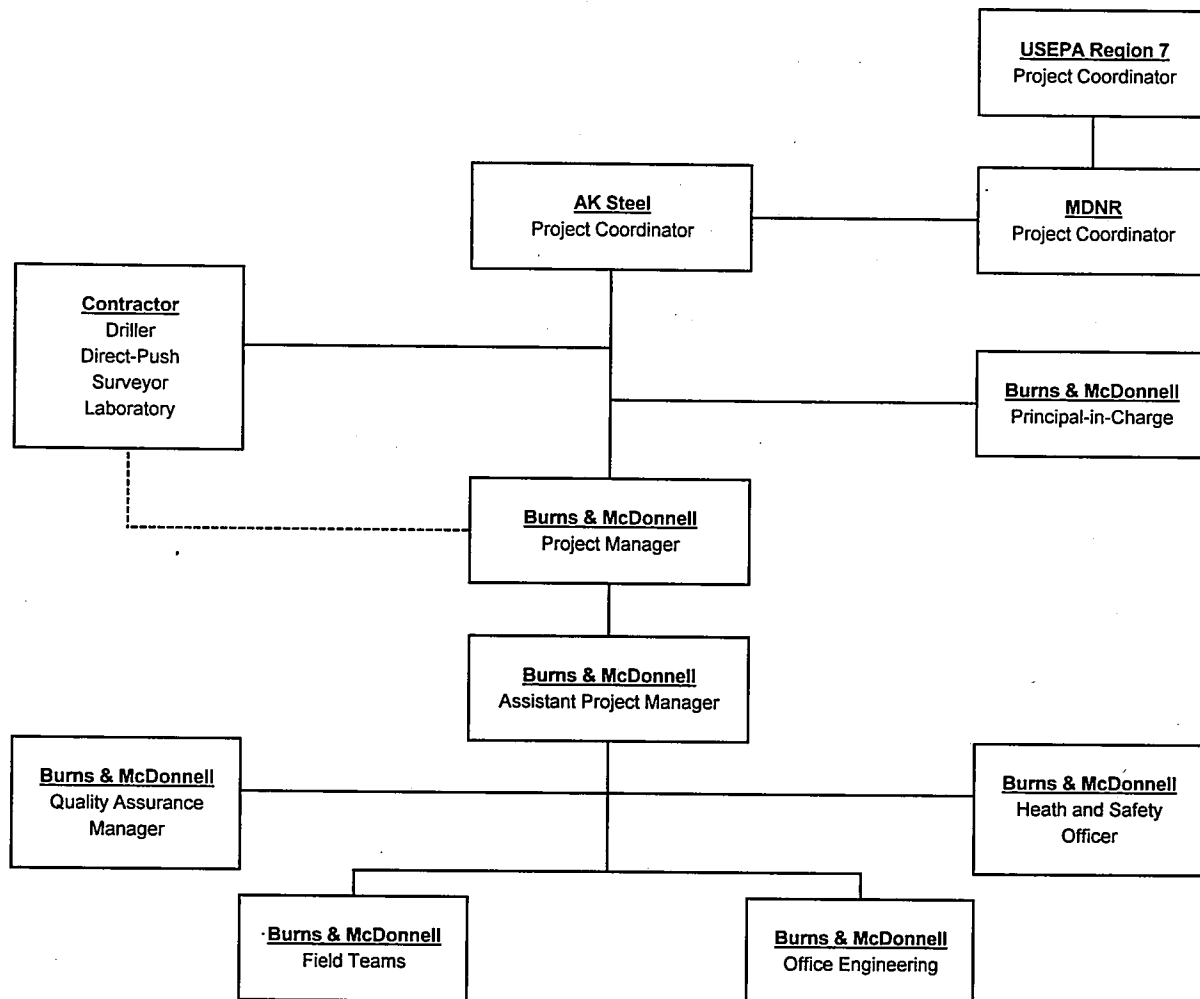
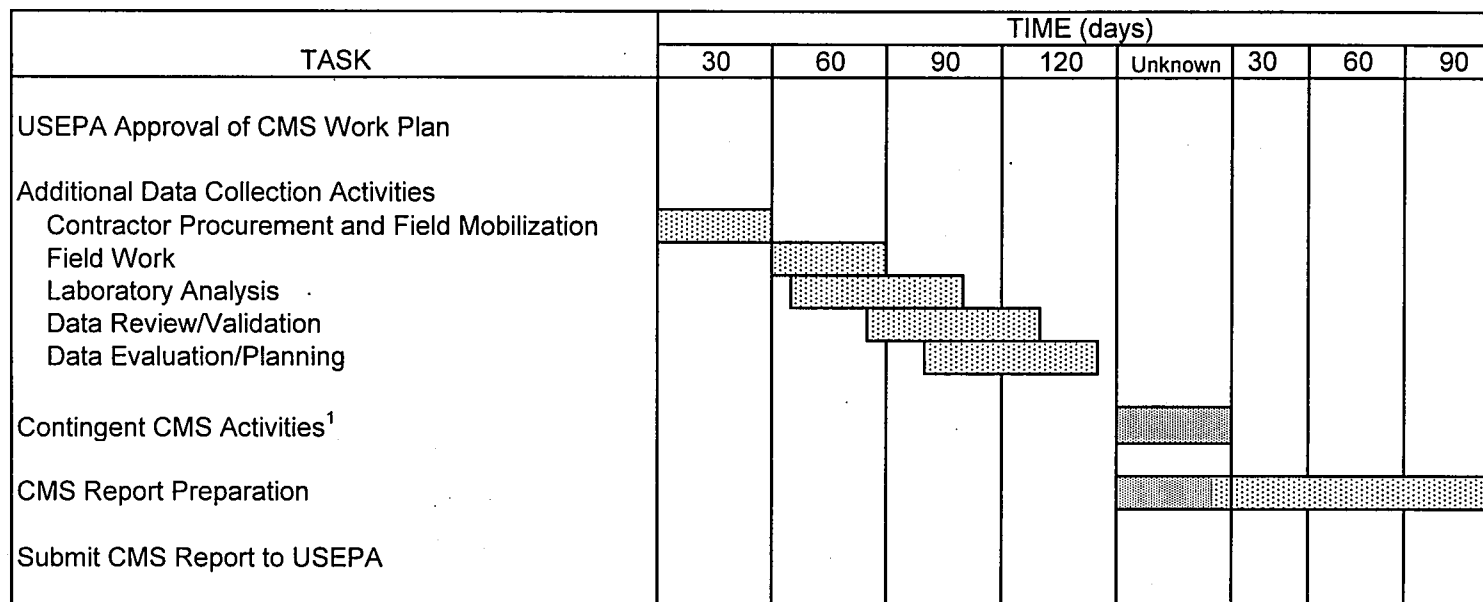


Figure 7-1

ORGANIZATION CHART

AK STEEL KANSAS CITY FACILITY



¹ If additional activities are needed to meet the objectives of the CMS, an extension to the project schedule will be required to define the scope of those activities and implement them. The schedule for these additional activities would be proposed in an Interim Data Document submitted to USEPA in lieu of the CMS Report.



Figure 7-2

PROJECT SCHEDULE

AK STEEL KANSAS CITY FACILITY

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**Appendix A
CMS Work Plan for
SWMUs 2, 3, 5, 7, 17, 33 and AOC 8**

**Corrective Action Objectives
AK Steel Kansas City Facility**

December, 2001

Project No. 29259

**Burns & McDonnell Engineering Company, Inc.
Engineers-Geologists-Scientists
Kansas City, Missouri**

TABLE OF CONTENTS

	<u>Page No.</u>
LIST OF TABLES	TC-2
1.0 INTRODUCTION	1-1
1.1 Purpose and Scope	1-1
1.2 Background	1-1
1.3 Report Organization	1-2
2.0 CHEMICALS OF POTENTIAL HEALTH CONCERN	2-1
2.1 Media of Potential Concern	2-1
2.2 Data Collection and Evaluation	2-1
2.3 Identification of Chemicals of Potential Concern	2-2
3.0 TOXICITY ASSESSMENT	3-1
3.1 Noncancer Health Effects	3-1
3.2 Cancer Health Effects	3-2
3.3 Chemicals without Toxicity Values	3-3
3.4 Health Effects of Lead	3-4
4.0 EVALUATION OF CORRECTIVE ACTION OBJECTIVES	4-1
4.1 Exposure Setting	4-1
4.2 Potentially Exposed Populations	4-2
4.2.1 Potentially Exposed Populations	4-3
4.2.2 Representative Populations	4-3
4.3 Potential Exposure Pathways	4-4
4.3.1 Full-Time Worker	4-4
4.3.2 Construction Excavation Worker	4-4
4.4 Development of Medium Specific Allowable Chemical Concentrations	4-5
4.4.1 Exposure Variables	4-6
4.4.1.1 Full-Time Worker	4-6
4.4.1.2 Construction Excavation Worker	4-7
4.4.2 Chemical Variables	4-8
4.4.2.1 Dust Concentrations	4-8
4.4.2.2 Vapor Concentrations	4-8
4.4.2.3 Gastrointestinal Absorption Adjustment	4-9
4.4.2.4 Dermal Exposure Variables	4-9
4.5 Uncertainty Analysis	4-10
4.5.1 Uncertainty from Chemical Identification and Quantification	4-10
4.5.2 Uncertainty from Toxicity Assessment	4-10
4.5.3 Uncertainty for Exposure Assessment	4-11
5.0 CORRECTION ACTION OBJECTIVES FOR LEAD	5-1
5.1 Overview	5-1
5.2 Input Parameters	5-1
5.3 Corrective Action Objectives for Lead	5-4

6.0	SUMMARY	6-1
6.1	Summary of Medium-Specific Allowable Chemical Concentrations	6-1
6.2	Soil and Groundwater Saturation Limits	6-1
7.0	REFERENCES	7-1

LIST OF TABLES

Table No.	Title
2-1	Screening Levels for Soil and Groundwater
2-2	Chemicals of Potential Concern
3-1	Summary of Noncancer Toxicity Information
3-2	USEPA Carcinogen Classification
3-3	Summary of Cancer Toxicity Information
4-1	Formula For Allowable Chemical Concentrations in Soil Based on Carcinogenic Effects
4-2	Formula For Allowable Chemical Concentrations in Soil Based on Noncarcinogenic Effects
4-3	Population Activity-Specific Adherence Factors
4-4	Particulate Emission Factor Equation
4-5	Volatilization Factor
4-6	Formula for Allowable Concentrations in Groundwater
4-7	Dermal Permeability Constant (Kp)
5-1	Blood Lead Concentration Calculations for Pregnant Worker
5-2	Blood Lead Concentration Calculations for Site Workers
6-1	Allowable Chemical Concentrations in Soil
6-2	Allowable Chemical Concentrations in Groundwater
6-3	Calculation of Soil Saturation Concentrations

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report presents the Corrective Action Objectives (CAOs) for Solid Waste Management Units (SWMUs) 2, 3, 5, 7, 17, 33 and Area of Concern (AOC) 8 at the AK Steel Kansas City Facility located in Kansas City, Missouri (Facility). Information from the *Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report* (Burns & McDonnell, 1999) was reviewed to identify site chemical concentrations, nature and extent of contamination, and physical site conditions for determination of CAOs for the Facility.

The CAOs are calculated allowable mean chemical concentrations for soil and groundwater at the site. The CAOs will be used to identify areas of the Facility, if any, where corrective measures may be appropriate. The intent of corrective measures will be to achieve a post-corrective action mean chemical concentration at or below the CAO, or to otherwise protect human health.

The Corrective Measures Study (CMS), as outlined in the main body of this CMS Work Plan, will evaluate potential measures or technologies to address the CAOs. Potential technologies include capping to limit contact with impacted media as well as institutional controls to restrict activities that could result in unacceptable exposures.

1.2 BACKGROUND

Background information for SWMUs 2, 3, 5, 7, 17, 33 and AOC 8 is presented in the main text of this CMS Work Plan and in the previous RFI document. A Human Health Risk Assessment (HHRA) evaluation was previously conducted as part of the RFI (Burns & McDonnell, 1999). The HHRA followed procedures outlined in the United States Environmental Protection Agency (USEPA) *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual* (1989) and other USEPA supplemental guidance documents.

This document incorporates findings of the HHRA including media of concern, potential contaminants of concern, potentially exposed populations, and completed exposure pathways. Additional details are provided in Appendices X and Y of the RFI (Burns & McDonnell, 1999).

1.3 REPORT ORGANIZATION

This report consists of the following chapters:

- Chapter 1.0 – Introduction
 - The first section introduces the general purpose of the report and explains the report organization.
- Chapter 2.0 - Chemicals of Potential Health Concern
 - In Chapter 2.0 of the report, analytical data representing current site conditions are reviewed and the chemicals detected are summarized. Selection of screening criteria is explained and chemicals of potential health concern (COPCs) are identified.
- Chapter 3.0 -Toxicity Assessment
 - Toxicity of the COPCs is discussed in Chapter 3.0. Both noncarcinogenic and carcinogenic toxicology is presented as well as a discussion of those chemicals for which there are no available toxicity data.
- Chapter 4.0 - Exposure Assessment
 - Chapter 4.0 considers current and planned future land use to identify possible receptor populations and potentially completed exposure pathways. CAOs are back-calculated based on a target risk of 1×10^{-5} excess cancer for carcinogens and a target hazard index of 0.3 for noncarcinogens. This target risk and hazard index allow for the presence of multiple chemicals while still maintaining acceptable risk and hazard levels. It is also recognized that multiple chemicals do not exist at all areas of the site. Therefore, for such circumstances a target risk of 1×10^{-4} and a hazard index of 1.0 are appropriate and the back-calculated values are also presented for this situation.
- Chapter 5.0 - Lead Risk
 - Chapter 5.0 addresses CAOs for lead. Lead is unique in that CAOs are not based on the same sets of equations and input variables as used for the other COPCs evaluated in Chapter 4.0.
- Chapter 6.0 - Summary
 - Chapter 6.0 provides a summary of the CAOs.

* * * * *

2.0 CHEMICALS OF POTENTIAL HEALTH CONCERN

COPCs include those chemicals detected at the Facility which have the potential to impact human health. The following sections detail the procedures undertaken to determine the COPCs for which CAOs have been determined. Section 2.1 presents the media of concern, Section 2.2 outlines the data collection and evaluation steps, and Section 2.3 details the identification of the COPCs.

2.1 MEDIA OF POTENTIAL CONCERN

In order to determine COPCs, it is necessary to establish potential media of concern. Sampling and analysis activities resulted in the detection of chemicals in surface and subsurface soils, sediment, and groundwater. Because chemicals in surface soil can be directly contacted by workers, exposure to surface soil could present potential human health concerns. Direct contact with subsurface soil could occur as the result of future construction including excavation activities such as grading, new utility installation, and foundation work. Therefore, soil is a medium of concern.

Potable water is supplied by the city of Kansas City, Missouri and there are no on-site wells for groundwater use; therefore, direct ingestion of contaminated groundwater is not probable. At the shallowest point, groundwater at the Facility is located approximately 5 feet below the ground surface. Direct contact with groundwater at a depth of 8 feet or less may be possible for receptors such as a construction worker. Potential inhalation of volatile contaminants in groundwater may also pose a risk to human health. For these reasons, groundwater is also a medium of potential concern at the Facility.

2.2 DATA COLLECTION AND EVALUATION

COPCs were identified through the review of analytical data collected during the RFI. Over the course of the investigation activities, approximately 130 surface soil, 140 trench soil, 120 test pit, 555 soil boring, 4 sediment, 4 surface water, 105 direct-push groundwater, and 55 monitoring well groundwater samples were submitted to the analytical laboratories resulting in more than 1,700 chemical analyses. Based on Facility history, chemical analyses were conducted primarily for lead, cadmium, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH). Other chemical analyses performed during the RFI included RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), pH, Skinner's list of VOCs, Skinner's list of SVOCs, hexavalent chromium, and natural attenuation parameters. RFI chemical analytical methods and parameter lists are summarized in Table 4-1

of the RFI Report. The media analyzed and the type of chemical analysis performed were determined by evaluation of historical operations for each area of the Facility. Specific information regarding the collection of data can be obtained from the RFI Report.

2.3 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

CAOs were calculated for all COPCs identified at the facility, not just for the COPCs associated with SWMUs 2, 3, 5, 7, 17, 33 and AOC 8. This is based on the possibility for a future full time outdoor worker (non-construction) or a construction excavation worker to be exposed to contaminants that are located anywhere at the Facility. The CAO calculations are conservative in that it is assumed that a future worker could be simultaneously exposed to all COPCs, even though many of the areas of the Facility are limited with respect to the number of COPCs that are present.

Appendix X and Y of the RFI (Burns & McDonnell, 1999) identified the COPCs using the following procedure. For each individual SWMU or AOC, a complete list of all chemicals detected was compiled. Concentrations of chemicals detected in soil or sediment were then screened against the Soil Screening Levels (SSLs) developed by USEPA (1996b) for both ingestion and inhalation. SSLs represent chemical-specific concentrations in soil that are back-calculated based on residential exposure assumptions and fixed levels of risk (i.e., a hazard quotient of 1 or excess cancer risk of 1×10^{-6}). Because SSLs were developed to be protective of residential populations they represent a conservative screening tool for an industrial site, such as AK Steel. SSLs for benzo(a)pyrene, chlorobenzene, naphthalene, chromium III, and chromium VI were recalculated or developed based on new or newly available toxicity values. For chemicals without previously published SSLs, SSLs were calculated following the SSL guidance (USEPA, 1996b) if toxicity values were available. With the exception of Class A carcinogens, chemicals detected at concentrations below the screening level were eliminated from further consideration. Class A carcinogens detected in soil were retained regardless of concentration.

Steel slag is the primary source of fill material in most areas at AK Steel. Data from background slag samples indicated that slag has minimal concentrations of hexavalent chromium (1.44 milligrams per kilogram (mg/kg)) in comparison to total chromium (3,540 mg/kg). This indicates that trivalent chromium is the predominant chromium species in slag (see Subsection 4.2.6.1 of the RFI Report). Therefore, detections of total chromium data in soil were screened as trivalent chromium at most SWMUs or AOCs that had this type of data. In samples collected from SWMU 12, separate analyses

were performed for hexavalent and trivalent due to the nature of historical activities at this location. Hexavalent chromium was not detected; therefore, only trivalent chromium was evaluated in the screening process.

Analytical data from groundwater was compared to Federal Maximum Contaminant Levels (MCLs) (USEPA, 1998). By definition, MCLs are enforceable standards for drinking water at the tap. Although groundwater at AK Steel is not used for either drinking or process water, MCLs were selected for groundwater screening purposes as a conservative measure. For chemicals without MCLs, risk-based screening levels were used as the basis for comparison. Risk-based levels were determined by using SSL ingestion equations with an ingestion rate of 1 liter/day for a child and 2 liters/day for an adult. Those chemicals detected in concentrations exceeding either MCLs or risk-based screening levels were retained for further evaluation. Class A carcinogens detected in groundwater were retained regardless of concentration.

Groundwater screening numbers for volatilization were developed by using the SSL partitioning equation to groundwater (USEPA, 1996a). The equation was rearranged to solve for the groundwater concentration based on the inhalation soil screening value using default SSL variable values. Those chemicals detected in concentrations exceeding calculated screening levels were retained as COPCs.

Acenaphthylene, benzo(g,h,i)perylene, and phenanthrene do not currently have screening levels, and toxicity values are not available to develop screening numbers. These chemicals were not retained as COPCs. However, in this appendix to the CMS Work Plan, CAOs are calculated for numerous other PAHs such as benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Addressing CAOs for this set of indicator PAHs is judged to address potential concerns associated with the PAHs for which toxicity values are not available (i.e., future corrective measures to address the indicator set of PAHs should simultaneously serve to address all PAHs given the co-occurrence and very similar physical and chemical properties that would affect mobility to an exposure point).

Detected concentrations of TPH were not screened. The term TPH refers to a mixture of hydrocarbons that includes a large number of constituents. The composition of the mixture is greatly variable as are the chemical characteristics of the individual components. Volatile petroleum hydrocarbons of primary interest may be reported as individual BTEX (benzene, toluene, ethylbenzene, xylene) constituents or as

total BTEX. Semivolatile petroleum hydrocarbons of interest include PAHs. Evaluating the human health risks associated with exposure to BTEX and PAHs serves as an appropriate means of evaluating TPH. TPH *per se* was not considered a COPC at AK Steel, but the BTEX and PAH constituents exceeding screening criteria were retained and evaluated.

A list of all screening values used is presented in Table 2-1. Table 2-2 summarizes COPCs at the Facility for all SWMUs and AOCs.

3.0 TOXICITY ASSESSMENT

The toxicity of chemicals is generally evaluated for both cancer and noncancer adverse health effects. Data regarding these effects are then used to derive numerical toxicity values. USEPA and other agencies gather toxicological information from a variety of sources including experimental animal studies and epidemiological investigations. Well-conducted epidemiologic studies that show a positive correlation between an agent and a disease represent the most convincing evidence about human risk. At present, human data adequate to serve as the sole basis for the development of toxicity values are available for only a few chemicals. In most cases where there is insufficient direct human data, USEPA uses toxicity information developed from experiments conducted on non-human mammals such as rats, mice, dogs, rabbits, etc.

The primary source of toxicological information for this report was the USEPA sponsored Integrated Risk Information System (IRIS) (USEPA, 2001); or the USEPA Region III Risk-Based Concentration Table (USEPA, 2001a) was consulted for toxicity values available through the USEPA Superfund Technical Support Center (STSC). In some cases, STSC will reference the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a) for some of the toxicity values.

The following sections detail information regarding both noncancer and cancer toxicity values.

3.1 NONCANCER HEALTH EFFECTS

The Reference Dose (RfD) and Reference Concentration (RfC) are the toxicity values used in assessing noncancer health effects from oral and inhalation exposures, respectively. For noncancer health effects, the level of exposure below which no adverse health effects develop is termed the threshold level or threshold dose. The RfD and RfC are exposure levels which are below threshold. Each represents an estimate of daily exposure to the general human population (including sensitive subpopulations) that is unlikely to pose an appreciable risk of adverse effects during a given term of exposure.

RfD and RfC values are typically derived from experimental NOAELs (no observed adverse effect levels) or LOAELs (lowest observed adverse effects levels) by application of uncertainty factors (UFs). UFs of 10 each are used to provide for the protection of sensitive subpopulations, account for interspecies variability, and account for data being obtained from subchronic rather than chronic studies. An additional UF of 10 is also used when the toxicity value is derived from a LOAEL rather than a NOAEL.

RfD values are expressed as milligrams of chemical per kilogram body weight per day (mg/kg/day), and RfC values are expressed as a chemical concentration in air in milligrams per cubic meter (mg/m³). For consistency with the inhalation intake dose units, RfC values are converted to inhalation RfD values, which are then expressed as mg/kg/day (USEPA, 1997a).

There are no dermal absorption toxicity values currently available, necessitating the use of oral toxicity values. However, oral values are typically developed from laboratory animal studies and reflect an administered (in feed or water) dose, rather than an internally absorbed (through the gastrointestinal tract) dose. Degree of gastrointestinal absorption varies widely among different chemicals with some being readily absorbed and some being poorly absorbed. To reflect this, gastrointestinal absorption efficiency factors may be applied for some chemicals. For this evaluation, no adjustments have been applied when extrapolating the oral to the dermal route. The exception is cadmium where a 5 percent adjustment factor was applied to the oral RfD.

source? Use that factor

Table 3-1 summarizes the available RfDs, reference sources, and primary noncancer health effects associated with exposure to each COPC.

3.2 CANCER HEALTH EFFECTS

The toxicity values used in assessing cancer risk are termed slope factors. A slope factor represents the 95 percent upper confidence limit on the probability that a carcinogen will cause cancer at a dose of one mg/kg/day over a lifetime. Unlike most noncancer health effects, carcinogenesis is not considered by USEPA to conform to the concept of a threshold (no effect) dose. USEPA risk assessment policy is to assume that even the smallest dose of a carcinogen can lead to a clinical state of disease. Any specific dose can be related to the statistical probability of a carcinogenic response.

For cancer effects, the substance is given a weight-of-evidence classification and a slope factor is calculated. To determine the weight-of-evidence classification, the available evidence is evaluated to determine the likelihood that the agent is a human carcinogen. Table 3-2 shows USEPA's carcinogen weight-of-evidence classification system. The slope factor is developed based on the potency of the agent as a carcinogen in experimental animals and/or humans. Slope factors are available in IRIS or STSC for many substances categorized by USEPA as A, B, or C carcinogens.

Slope factors are not available in IRIS or HEAST for most of the PAHs, except benzo(a)pyrene. Since evidence from animal studies shows other carcinogenic PAHs are generally much less potent than

benzo(a)pyrene, USEPA (1993) has developed toxicity equivalency factors (TEFs) to modify the benzo(a)pyrene oral slope factor to more accurately characterize cancer risk associated with PAHs. The STSC slope factors extrapolated from benzo(a)pyrene are based on TEF values of 1.0 for dibenzo(a,h)anthracene; 0.1 for benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene; 0.01 for benzo(k)fluoranthene; and 0.001 for chrysene.

As with RfDs, slope factors are not available for dermal exposure. No absorption efficiency factors were used for converting oral slope factors to dermal slope factors in this report. Table 3-3 summarizes the available slope factors, reference sources, weight-of-evidence classifications, and target organs for the listed cancer effects of each COPC.

3.3 CHEMICALS WITHOUT TOXICITY VALUES

Acenaphthylene is a chemical detected at the Facility for which there are no toxicity values available in the literature. Toxicity values are not listed in IRIS, and HEAST states that there is inadequate data to quantitatively assess its risk. Acenaphthylene was detected in less than 15 percent of the samples at AOC 1. Based on its infrequent detection and given the numbers and types of chemicals being assessed, it is doubtful that site-related risk would be underestimated by excluding acenaphthylene.

Toxicity values are also not available for benzo(g,h,i)perylene. Toxicity values are not listed in IRIS, the chemical is not listed in HEAST, and the *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (USEPA, 1993) does not provide additional information. Because benzo(g,h,i)perylene was detected only in low concentrations in areas with low exposure potentials, it is unlikely that its exclusion would lead to underestimated site-related risk.

Phenanthrene is also a chemical for which there are no toxicity values available. Toxicity values are not listed in IRIS, and HEAST states that the data available is inadequate for quantitative risk assessment. Current data indicates that as an isomer of anthracene (a low toxicity noncarcinogen), phenanthrene is noncarcinogenic with little observed toxicity. Due to its presumed low levels of toxicity, and given the numbers and types of chemicals being assessed, it is unlikely that its exclusion will lead to underestimated site-related risk.

3.4 HEALTH EFFECTS OF LEAD

Lead represents a special situation with regard to both its cancer and noncancer toxicities. Lead is categorized as B2, a probable human carcinogen, but also produces neuropathic effects which do not appear to have a threshold. Additionally, it has been difficult for USEPA and others to identify adequate studies from which to develop toxicity factors. For these and other reasons, USEPA has concluded that it would not be appropriate to set numerical toxicity values for lead.

An approach for assessing nonresidential adult lead risks is a modification of the Bowers method, which relates soil lead intake to blood lead concentrations (USEPA, 1996). The Bowers method evaluates risk from ingestion of lead in soil and dust. This method is explained in Section 5.0.

For drinking water, the action level for lead is 0.015 milligrams per liter (mg/L), which can be used as a screening tool to determine if there is a potential for risk. However, water at AK Steel is not used for drinking water and therefore the only reasonably likely route of exposure is through dermal contact. Lead in non-potable water is not likely to pose a significant risk since, in general, metals are not significantly absorbed through the skin. Lead, in particular, is very poorly absorbed through the skin (ATSDR, 1998). Therefore, it was not deemed necessary to evaluate dermal exposure to lead in water.

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4.0 EVALUATION OF CORRECTIVE ACTION OBJECTIVES

In this section of the report, potentially exposed populations and potential pathways of exposure are identified. This exposure assessment considers land use and zoning, among other factors, in order to identify pathways and populations for exposure. Only completed exposure pathways (i.e., human receptors in contact with contaminated media) may actually pose some human health risk. Section 4.1 presents a description of the exposure setting, Section 4.2 discusses the likelihood for a human population to have direct contact with contaminated media at the Facility, Section 4.3 identifies potential exposure pathways, Section 4.4 presents the equations and variables involved in the quantification of the CAOs, and Section 4.5 discusses uncertainties. Section 6.0 presents the calculated CAOs.

4.1 EXPOSURE SETTING

This section of the report provides information regarding the exposure setting at AK Steel including details about land use, surface water use, groundwater use, and environmental setting. The information in these sections is abbreviated from that presented in Section 2.0 (Environmental Setting) of the RFI Report, which should be referred to for additional information as well as the main body of this CMS Work Plan.

Land use near the Facility is characterized by medium to heavy industrial development. The Facility is zoned M2A - Heavy Industrial by the city of Kansas City. Localized residential developments are located to the southeast and to the west of the Facility. Overland access to the Facility by the public is limited by perimeter fencing, gates, and guards throughout most of the Facility. The Facility is, however, marginally accessible from the Blue and Missouri Rivers and from Rock Creek.

Major surface water bodies in the vicinity of the Facility include the Blue River, Rock Creek, and the Missouri River. Virtually all of the Facility is within the 100-year flood boundary shown in Figure 2-3 of the RFI Report.

The Blue River roughly bisects the area of the Facility south of the Kansas City Terminal Railway bridge. North of the Kansas City Terminal Railway bridge crossings, the Blue River forms the western, northern, and northwestern Facility boundary; meandering north and northeast toward the Missouri River. The Blue River traverses approximately 4.35 river miles (2.37 straight line miles) from the south end of the property at SWMU 3 to the confluence with the Missouri River. The Blue River channel through the

Facility has been paved (approximately 0.67 miles) or lined with rip-rap (approximately 2.0 miles) for flood control. The paved portion of the Blue River channel is adjacent to the boundary of SWMU 33.

Rock Creek bounds the southern edge of the Facility east of Interstate Highway 435 from approximately AOC 8 to the Missouri River, a distance of approximately 1.5 miles. SWMU 12 is surrounded by a former meander loop of Rock Creek which was cut off when the channel was deepened and straightened.

The Missouri River bounds the northeastern edge of the Facility at the barge dock. SWMU 12 is the nearest SWMU to the river at a distance of approximately 2,600 feet.

Groundwater flow beneath the Facility is generally to the north-northeast toward the Blue and Missouri Rivers. Site hydrogeology varies between the Blue River and Missouri River dominated floodplains:

- The Blue River dominated floodplain is characterized by an upper, unconfined saturated zone underlain by a lower, semiconfined saturated zone. The semiconfining clay layer was encountered at approximately 40 feet bgs, and is expected to be less than 20 feet in thickness. Water level elevations in the upper unconfined saturated zone ranged from 730 to 740 feet above Mean Sea Level (MSL) (5 to 15 feet bgs). Water level elevations in the lower semiconfined saturated zone ranged from 715 to 725 feet above MSL (20 to 30 feet bgs).
- The Missouri River dominated floodplain is characterized by a single, unconfined saturated zone. Water level elevations ranged from 720 to 740 feet above MSL (5 to 25 feet bgs).

Groundwater is not currently used for any purpose at the Facility. Potable water is supplied by the city of Kansas City, Missouri. It is anticipated that groundwater use will not change in the future.

4.2 POTENTIALLY EXPOSED POPULATIONS

Potentially exposed populations include those persons whose locations and activities create an opportunity for contact with COPCs. The following subsections discuss potentially exposed populations as they are influenced by Facility land use. Section 4.2.1 discusses populations actually or potentially present at each area and Section 4.2.2 discusses which of these populations were chosen for risk characterization in the HHRA.

4.2.1 Specific Populations

Existing receptor or potential future populations at the Facility include as follows:

- **Landfill Cap Maintenance Workers:** Several SWMUs at the site are closed landfills with a vegetated soil cover. Cap maintenance workers are a non-routine worker population present infrequently at the SWMUs. Landfill maintenance work could consist of repair of the soil cover and landscape work including mowing, seeding, and weed control.
- **Utility Workers:** Existing utilities at the Facility include, but are not limited to, natural gas lines, telephone cables, storm/sanitary sewers, and water lines. Subsurface utilities may require repair or new lines may require installation based on future development of the property.
- **Transient Workers:** Includes workers such as locomotive engine operators, delivery truck drivers, and other types of visitors who occasionally enter or pass through the Facility.
- **Construction Workers:** Construction workers could be required for possible future building expansion activities or highway construction. Some of the workers could be involved in earthwork activity including utility installation and foundation construction.
- **Full Time Workers:** Full-time workers could be routinely at the Facility eight hours per day, five days per week. The population could include truck drivers, fork-lift operators, warehouse employees, manufacturing personnel, supervisory staff, clerical workers, etc. associated with industries located or potentially located at the Facility in the future.
- **Trespassers:** ^{Hunter} Main access is fenced off and AK Steel is continuing activities to make the Facility more inaccessible. However, occasional trespassers, typically adults, have been known to enter areas to hunt in the past. Since this is a controlled access facility, child trespassers are very unlikely.

4.2.2 Representative Populations

While many different populations are potentially present at the Facility, a full-time worker and a construction excavation worker were evaluated for the calculation of CAOs. These two-worker-scenarios conservatively represent the chemical exposures and durations that could be experienced by the entire subset of worker types and potential trespassers at the site. Full-time workers would have a greater exposure opportunity and duration than part-time workers, mowers, adult trespassers, or truck drivers in

any area. Therefore, representing part-time workers or other infrequently present populations with a full-time worker is a conservative measure. Further, the full-time worker scenario is appropriate considering the possibility of future industrial activities. A construction excavation worker scenario was also included for the development of CAOs because of the potential for unique exposure for this population associated with excavation activities (see Section 4.3).

4.3 POTENTIAL EXPOSURE PATHWAYS

Health risks may occur when a receptor population has contact with a chemical. The receptor must then either ingest, inhale, or dermally absorb COPCs to complete an exposure pathway and experience a health risk. The following is a discussion of the likelihood of completed pathways.

4.3.1 Full-Time Worker

Full-time workers who spend time outdoors may contact surface soil directly or in the form of settled dust outside or in the workplace. Contact with surface soil could lead to incidental ingestion of chemically impacted soil as well as chemical absorption through dermal contact. Fugitive dust generated by wind from surface soil could also be inhaled. A full-time worker is unlikely to have direct contact with subsurface soils. If volatile organic compounds are present in surface or subsurface soil, vapors may migrate through soils and be present in the breathing atmosphere of a full-time worker.

There are no water supply wells on-site; therefore, a full-time worker is not likely to directly contact groundwater. If volatile organic compounds are present in groundwater, vapors may migrate through soils and be present in the breathing atmosphere of a full-time worker.

In summary, the exposure pathways considered potentially complete for the full-time worker scenario are:

- Incidental ingestion of chemically impacted surface soil
- Absorption of chemicals through dermal contact with impacted surface soil
- Inhalation of chemically impacted fugitive dust from surface soil
- Inhalation of chemical vapors from impacted soil or groundwater

4.3.2 Construction Excavation Worker

Should excavation work be required at a SWMU or AOC in the future, workers could directly contact surface and subsurface soil. Exposure of this type could possibly be of relatively heavy intensity, but a shorter duration (i.e., one year). Direct contact with soil could lead to incidental ingestion and chemical

absorption through dermal contact. During excavation work, fugitive dust from soil could be generated and subsequently inhaled. If volatile organic compounds are present in surface or subsurface soil, vapors may migrate through soils and be present in the breathing atmosphere of a worker.

In areas where groundwater is shallow, groundwater could be directly contacted during excavation activities and dermal absorption of chemicals may occur. If volatile organic compounds are present in groundwater, vapors may be present in the breathing zone of a construction excavation worker.

In summary, the exposure pathways considered potentially complete for the construction excavation worker scenario are:

- Incidental ingestion of chemically impacted soil
- Absorption of chemicals through dermal contact with impacted soil
- Inhalation of chemically impacted fugitive dust from soil
- Absorption of chemicals through dermal contact with impacted groundwater
- Inhalation of chemical vapors from impacted soil or groundwater

4.4 DEVELOPMENT OF MEDIUM-SPECIFIC ALLOWABLE CHEMICAL CONCENTRATIONS

Allowable chemical concentrations for human health protection are medium-specific remediation goals based on risk assessment methodology or compliance with regulatory criteria.

Risk-based allowable concentrations inclusive of all relevant exposure pathways were calculated for each potentially exposed. Target cancer and/or noncancer risk levels, toxicity values, and specific exposure pathways were combined to back-calculate allowable chemical levels that do not pose unacceptable risk.

This section of the human health evaluation presents the calculation of risk-based allowable chemical concentrations based on exposure pathways and scenarios identified in Subsection 4.3. Allowable chemical concentrations were calculated using the equations presented in RAGS Volume I Part B, Development of Preliminary Remediation Goals (USEPA, 1991a). Equations used for calculating risk-based concentrations based on cancer and noncancer health effects for soil are presented on Tables 4-1 and 4-2, respectively. Equations used for groundwater are presented on Table 4-6. When developing risk-based concentrations, unlike traditional risk assessment, chemical intake was not calculated separately for each exposure pathway. Allowable chemical concentrations were intended to be protective

of exposures from all relevant pathways; therefore, intake parameters for each relevant pathway were combined into one equation to provide a single cumulative risk-based concentration. The equation combines the toxicity values presented in Section 3.0 with the exposure variables, chemical variables, and target risk levels presented in Subsections 4.4.1 and 4.4.2

4.4.1 Exposure Variables

For the calculation of CAOs for all chemicals except lead, recommended default exposure variable values from guidance documents were used when available. The default exposure variables were used primarily to promote ready acceptance of the CAOs for the conventional chemicals and to allow special attention for lead, which is the chemical most likely to drive the CMS. Use of the default variables for the conventional chemicals does not indicate that they are believed to be the most appropriate or most scientifically supportable. Since exposure to lead is assessed using a unique method and because it is a critical chemical of concern, the best available information was used to calculate lead CAOs. For the conventional chemicals, variables for the full-time worker and excavation worker populations are presented in Tables 4-1 through 4-7. For lead, variables are presented on Tables 5-1 and 5-2 with additional explanatory text in Section 5.0 of this report. ^{no}

4.4.1.1 Full-Time Worker

A full-time worker was assumed to weigh 70 kilograms (kg) (USEPA, 1989), the recommended adult weight. Since weight and body surface area are directly related, use of mean weight requires use of mean surface area for consistency. In calculating dermal absorption of chemicals from surface soil, 3,160 square centimeters (cm²) was used as the total area for skin absorption based upon the mean value for the hands, forearms, and head of adult males (USEPA, 1997). This absorption area was assumed to represent both winter and summer conditions. ^{3,300 cm²}

The adherence factor was calculated by averaging body part-specific adherence factors weighted by the surface area of the body part according to methodology found in the *Exposure Factors Handbook* (USEPA, 1997). Body part-specific adherence factors for the full-time worker were based on the "Groundskeepers No. 1" field study group which evaluated adults outdoors on campus grounds in long pants and with intermittent use of gloves (USEPA, 1997). The adherence factor for a full-time worker was calculated to be 0.04 milligrams per square centimeter (mg/cm²) (see Table 4-3).

.2 for all adult workers ^{SSL} Probs Para 5

For the inhalation intake calculations for dust and chemicals vapors, it was assumed that a full-time worker breathes 1.5 cubic meters of air per hour (m³/hr) (USEPA, 1997). This is a mean value based on a

moderate activity level for an adult outdoors. The default assumed incidental soil ingestion rate of 50 milligrams per day (mg/day) (USEPA, 1991) was used to estimate intake for full-time workers. The variable of fraction ingested from a contaminated source was assumed to be 1 (100 percent).

The standard 250 workdays per year for 25 years was used for exposure frequency and duration, respectively (USEPA, 1991). Full-time workers were to spend 100 percent of their time outdoors. The exposure time for inhalation of fugitive dust and chemical vapors was set at 8 hours per day.

4.4.1.2 Construction Excavation Worker

A construction excavation worker was assumed to weigh 70 kg (USEPA, 1991), the standard default adult weight. In calculating dermal absorption of chemicals from soil, ^{3,300 cm²}~~3,160~~ cm² was used as the total area for skin absorption based on the mean value for head, hands, and forearms of adult males (USEPA, 1997). For calculating dermal absorption of chemicals from water, 6,310 cm² was used as the total area of skin in contact with water based on the mean value for hands, forearms, lower legs, and feet of adult males (USEPA, 1997).

The soil-to-skin adherence factor was calculated by averaging body part-specific adherence factors weighted by the surface area of the body part. Body part-specific adherence factors for the excavation worker were based on the "Utility Worker No. 1" field study group which evaluated adults working in long pants, short sleeves, socks, boots, and sometimes gloves (USEPA, 1997). The adherence factor for an excavation worker was calculated to be 0.22 mg/cm² (see Table 4-3).

For the inhalation intake calculations for fugitive dust and chemical vapors it was assumed that the excavation worker breathes 2.5 m³/hr (USEPA, 1997). This is a mean value based on a heavy activity level for a worker outdoors. An assumed incidental soil ingestion rate of 330 mg/day (USEPA, 2001c) was used to estimate intake for excavation workers. This theoretical rate is approximately seven times the standard default for adults, as it is assumed that excavation activities lead to greater soil contact opportunity. The variable fraction of soil ingestion from a contaminated source was assumed to be 1 for the excavation worker population.

Based on best professional judgment, it was estimated that a construction excavation worker is at a job site for 8 hours per day for a total of 182 days for a one year duration. The 182 days are dry days (no measurable rain or snow) during which construction would be expected to proceed normally. The 182 dry days are based on a 73 percent proportional reduction of 250 work days (USEPA, 1991) using 265

total dry days per year (USEPA, 1988). It was also assumed that for 25 of the 182 days some workers may be dermally exposed to shallow groundwater. This is assumed to be a one-time exposure, therefore the exposure duration used was one year.

4.4.2 Chemical Variables

4.4.2.1 Dust Concentrations

Dust generation produces a potential chemical exposure situation. Since dust concentrations were not measured during the RFI, chemical concentrations in dust were predicted. The exposure concentrations for inhalation depend on the concentration of suspended particulates in air (dust), the fraction of dust that is respirable, and the fraction of dust that is derived from a contaminated source. For most exposure scenarios in the risk assessment, a value of 26 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) was used as the airborne dust concentration (Table 4-4). This value is based on the 95% UCL of the mean for 6 years data on respirable particulates (PM10) for Kansas City compiled by the Missouri Department of Natural Resources (MDNR, 1999). Respirable particulates are generally defined as particles with air aerodynamic diameter less than 10 micrometers in size.

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Due to the dust-generating activities typically engaged in by an excavation worker, the concentration of airborne dust would be expected to be higher than that for a general outdoor worker. Therefore, a value of $257 \mu\text{g}/\text{m}^3$ was used as the airborne dust concentration for the excavation worker scenario. This value is based on investigations compiled in the Gas Research Institute's *Management of Manufactured Gas Plant Sites, Volume III – Risk Assessment* (GRI, 1988).

An adjustment of the airborne dust concentration value was made for the excavation worker inhalation of dust scenario to calculate the fraction of airborne dust that is considered respirable (Table 4-4). Consistent with current research, it was assumed that 73 percent of the dust generated is respirable (HRI, 1995). This adjustment was not necessary for the other scenarios because the value of $26 \mu\text{g}/\text{m}^3$ was based on respirable particulate levels instead of total dust levels. For all scenarios, it was assumed that 100 percent of dust is from a contaminated source. Generally, this is probably a reasonable assumption for the excavation worker, but an overestimation for other workers.

4.4.2.2 Vapor Concentrations

The volatilization factor (VF) equation is presented in Table 4-5 and represents the media transfer from soil to air. The VF equation used in this evaluation was obtained from USEPA Soil Screening Guidance (USEPA, 1996) and combines an estimate of the chemical flux from soil with a simulation of contaminant

dispersion in ambient air. The estimate of chemical flux from soil is based on a commonly used partitioning equation, and the simulation of contaminant dispersion in ambient air is represented by the Q/C term.

The Q/C term reflects the results of air dispersion modeling conducted by USEPA using varying contaminant source sizes and meteorological conditions. The Q/C value used in this evaluation represents a source size of 30 acres and midwestern United States (Lincoln, Nebraska) meteorological conditions. The remainder of the equation, which represents emission or flux of vapors to the surface, is based upon the model developed by Jury et al. (USEPA, 1996). The emission component of the equation was dependent on chemical physical properties and soil parameters. The chemical physical properties used in this evaluation are shown on Table 4-5. Soil parameters used in this evaluation using site-specific data are identified on Table 4-5.

4.4.2.3 Gastrointestinal Absorption Adjustment

An absorption adjustment factor (AAF) can be used to adjust the exposure dose to account for differences in bioavailability between laboratory dosing vehicles and environmental matrices. While AAFs are not available for the oral route for most chemicals, an AAF has been developed for oral absorption of PAHs in soils. The point estimate of the oral-soil AAF for PAHs is 0.29 (Magee et al, 1996). Therefore, the intake of PAHs for the incidental ingestion pathway is adjusted by a factor of 0.29. All other chemicals were conservatively assumed to have an AAF of 1.

4.4.2.4 Dermal Exposure Variables

In estimating absorption of chemicals in water, chemical-specific permeability constant (Kp) values in units of centimeters per hour (cm/hr) are used (Table 4-7). If available, published Kp values from USEPA's *Dermal Exposure Assessment: Principles and Applications* (1992) are used and referenced. For inorganic chemicals without published Kp values, the Kp value for water is typically used instead. Kp values for COPCs in the evaluation were selected following this procedure.

There is very limited information available on skin absorption of specific chemicals from a soil matrix. Benzo(a)pyrene is one of the few chemicals specifically discussed in *Dermal Exposure Assessment: Principles and Applications* (USEPA, 1992). The guidance presents several studies which give a range of absorption factors for benzo(a)pyrene. The study judged to be the most appropriate for this risk assessment gave an absorption factor of 0.014 over a period of 24 hours. This absorption value was applied for all carcinogenic PAHs (Table 4-1 and 4-2). Absorption values of 0.10 for the remaining

SVOCs and 0.01 for VOCs and inorganic chemicals were used as a reflection of USEPA Region VII policy currently under development (Pers. Com., 1998).

The use of permeability constants and absorption factors (for chemicals in water and soil, respectively) in the intake calculation for the dermal exposure route results in an estimate of absorbed dose. This absorbed dose must then be used in conjunction with a toxicity value for the back-calculation of CAOs.

4.5 UNCERTAINTY ANALYSIS

Conducting a risk assessment or calculation of CAOs requires using a variety of information and making a number of judgements any or all of which may serve to introduce degrees of uncertainty in the final result. The following sections discuss the uncertainties resulting from chemical identification and quantification, toxicity assessment, and exposure assessment.

4.5.1 Uncertainty from Chemical Identification and Quantification

At any site, it is possible that there are more individual chemical substances present than identified in the sampling and analysis effort. The selection of media to be sampled, number of samples, and analyses requested are determined by a review of the history of the site, information on current conditions, and an evaluation as to which chemicals could potentially be present.

For this evaluation, historical information was available regarding the SWMUs and AOCs. This information was reviewed and applied in the development of the sampling and analysis plan during the RFI. The sampling plan included coverage for all substances suspected to be present. The wide parameter coverage provides confidence that the chemical residuals present at each SWMU or AOC have been identified.

Given the nature of the Facility and the level and identity of the chemicals analyzed in the sampling efforts, it is unlikely that chemical constituents went undetected. Therefore, the chemical identification and quantification phase of the risk assessment does not appear to have introduced significant uncertainty. In addition, when a COPC was detected in a media such as groundwater, it was assumed that it could also be a COPC in other media such as soil for the purpose of calculating CAOs.

4.5.2 Uncertainty from Toxicity Assessment

For some chemical substances there is little or no toxicity information available, and, for many, what is available is typically from animal studies. The relative strength of the available toxicological information

generates some uncertainty in the evaluation of possible adverse health effects and the exposure level at which they may occur. To provide a margin of safety, USEPA applies conservative adjustments to the toxicity values. However, when no toxicity values are available for a chemical, or exposure route, a CAO is not calculated for that particular chemical.

For noncarcinogenic substances, RfD and RfC values are typically established only after uncertainty and/or modifying factors are applied. These factors may result in an RfD/RfC that is as little as a thousandth or less of the "safe" dose level determined through animal studies.

For carcinogens, the slope factor represents the 95 percent upper confidence limit of the extrapolated low dose response curve. The actual carcinogenic potency of a substance at low doses is almost certainly less. Additionally, many substances identified as carcinogens in high-dose laboratory testing may not be carcinogenic at low doses and/or may not be carcinogenic to humans.

The use of surrogate toxicity values may introduce uncertainty. For instance, slope factors are not available for most PAHs, except benzo(a)pyrene. USEPA guidance recommends modifying the oral slope factor for benzo(a)pyrene with toxicity equivalency factors so that potential risk from all carcinogenic PAHs can be quantified. Adjusted slope factors are considered surrogate toxicity values and their use may not accurately describe risk.

Numerical toxicity values for dermal exposures have not been developed by the USEPA. To quantitatively assess risk from dermal exposure, USEPA guidance allows adjusting oral RfDs and slope factors, usually represented as administered instead of applied doses, by chemical-specific absorption factors to account for gastrointestinal absorption. Because of the potential differences in patterns of distribution, metabolism, and excretion between oral and dermal routes of exposure, use of adjusted oral toxicity values may either overestimate or underestimate risk, depending on the chemical. For calculating the CAOs, no adjustments were applied to the COPCs for dermal exposure with the exception of cadmium. ← correct

4.5.3 Uncertainty from Exposure Assessment

When evaluating exposure, probable scenarios are developed to estimate conditions and duration of human contact with COPCs. Scenarios are based on observations or assumptions about the current or potential activities of human populations which could result in direct exposure. To prevent underestimation of any risk, scenarios incorporate exposure levels, frequencies, and durations at or near

the top end of the range of probable values. This is sometimes termed a reasonable maximum exposure – one that may be unlikely or at the high end of a range of exposures, but still possible.

Default values, such as respiration rates, are used in the exposure calculations to quantify intake. Although they are based on USEPA-validated data, there is uncertainty in the applicability of such values to any particular exposed population or individual. To compensate for this uncertainty, the default values are typically set to the upper end (usually 90th or 95th percentile) of the normal range.

The USEPA default adult worker soil ingestion rate of 50 mg/day was used in the noncancer and cancer risk characterizations for the full-time worker even though this rate is not supported by recent research. Additionally, the recommended value of 330 mg/day (USEPA, 2001c) was used for the excavation worker even though the authors (Calabrese, et al 1997) of the study considered it unreliable. The use of 50 mg/day and 330 mg/day most likely exaggerates the cancer and noncancer risk due to ingestion of soil. Their use, as discussed earlier, was intended to facilitate regulatory acceptance of the CAOs for the non-lead compounds.

no ← no basis for the!
A value for soil ingestion of 10 mg/day, derived from more recent studies and believed to be more accurate than the default rate, was used in the adult lead model (see Section 5.0). The reasons for doing so were that lead is assessed by a unique method in which the soil ingestion rate is a critical element and it will most likely drive the CMS.

Uncertainty associated with vapor modeling is introduced because models are simplified representations of reality. When partitioning chemicals from groundwater, it is assumed that the maximum amount of chemical that can physically volatilize from the water will volatilize, without taking into account the less than ideal condition, adsorption to soil particulates, or degradation over time. Soil physical properties used in both soil and groundwater vapor modeling calculations were occasionally default values rather than site-specific measurements.

All of these factors contribute to uncertainty in the development of CAOs. Where there is uncertainty with respect to an input parameter, conservative input values are generally selected so as to produce conservative CAOs.

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5.0 CORRECTIVE ACTION LEVELS FOR LEAD

5.1 OVERVIEW

Lead is not evaluated using the same method documented in Section 4.0 for the other COPCs. The approach used is based on the Technical Review Workgroup (TRW) for Lead (USEPA, 1996) for assessing nonresidential adult lead risks. This methodology relates soil lead intake to blood lead concentrations in women of child-bearing age with the ultimate intent of protecting fetuses from excessive exposure. In a recent comparison of this method with six additional lead risk methodologies, the TRW concluded that the 1996 methodology should be retained given that the other reviewed methodologies produced similar estimates when input values were normalized across all models (USEPA, 2001b). This methodology uses a simplified representation of lead biokinetics to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of site exposure.

The equations and input parameters are shown on Tables 5-1 and 5-2. The following paragraphs provide additional information on the input parameters and worker scenarios.

5.2 INPUT PARAMETERS

Blood Levels Goals: Current Office of Solid Waste and Emergency Response (OSWER) guidance calls for the establishment of cleanup goals that limit childhood risks of exceeding 10 micrograms of lead per deciliter of blood ($\mu\text{g}/\text{dL}$) to 5 percent.

Therefore, this methodology estimates the relationship between blood lead concentrations in adult women and the corresponding 95th percentile fetal blood lead concentration. Although a pregnant female worker being on site full-time and exposed to lead in a SWMU or AOC is a highly unlikely scenario, this scenario was evaluated in accordance with USEPA guidance. The equation and site-specific variables for calculating the 95th percentile fetal blood lead concentration can be found on Table 5-1.

Since the pregnant female worker scenario is an unlikely one, it is necessary to include a more representative population in the lead evaluation. Therefore, a second set of blood lead calculations was performed for the full-time outdoor worker and construction excavation worker and to evaluate more likely site-specific exposure scenarios. These values represent a generic non-pregnant worker, who may be male or female. The standard used as the blood lead concentration limit for the generic full-time

outdoor worker was 20 $\mu\text{g/dL}$ (ATSDR, 1998). The equation and variables for calculating CAOs for generic full-time outdoor worker and construction excavation worker are presented on Table 5-2.

Individual Geometric Standard Deviation of Blood Lead: The TRW estimates that 1.8 to 2.1 is a plausible range for the individual geometric standard deviation (GSD) of blood lead concentrations among a population of pregnant women. A value of 1.8 was chosen for the pregnant worker based on the assumption that the population at the Facility would be more homogeneous than the U.S. population with respect to racial, ethnic, cultural, and socioeconomic factors that may affect exposure. For the generic full-time outdoor worker and construction excavation worker blood lead concentration calculations, a GSD of 1.8 was also used based on the likelihood of low variability in a population for such a small, site-specific area.

Typical Blood Lead Concentrations: Blood lead concentrations for the pregnant worker are based on TRW default values ranging from 1.7 to 2.2 $\mu\text{g/L}$. The geometric mean lead concentration in women of child-bearing age not exposed to lead-contaminated soil and dust from the Facility (PbBo) was assumed to be 2.0 $\mu\text{g/dL}$, based on the mean value reported in the NHANES III study for Caucasian (1.7 $\mu\text{g/dL}$), Hispanic (2.0 $\mu\text{g/dL}$), and African American (2.2 $\mu\text{g/dL}$) women aged 20 to 49. The fetal-to-maternal blood lead concentration ratio (R) used was the TRW recommended default of 0.9.

TRW does not address a non-pregnant worker population. The geometric mean lead concentration of workers not exposed to lead-contaminated soil and dust from the Facility (PbBo) was assumed to be 2.6 $\mu\text{g/dL}$, based on the mean value reported in the NHANES study for men and women age 20 to 49 (Brody et al, 1994).

Biokinetic Slope Factor: The biokinetic slope factor (BKSF) parameter relates the blood lead concentration to lead uptake in the body. The TRW recommended value of 0.4 $\mu\text{g/dL}$ blood per μg lead absorbed/day was used for the BKSF.

Lead Bioavailability in Soil: The absolute absorption fraction (bioavailability) of lead in soil was the TRW recommended default of 0.12. These values were used in both the pregnant and generic non-pregnant worker scenario calculations.

Mean Daily Intake of Soil: The commonly used default adult soil ingestion rate for commercial/industrial workers is 50 mg/day based on the OSWER Directive 9285.6-303 (USEPA, 1991).

Cite new TRW guidance too.
L case TRW Adult 2005
Guidance to new

The basis for this value is one study by Calabrese, et al (1990) and a paper by Hawley (1985). This default value was used in Section 4.0 of this report to facilitate acceptance of the CAOs even though this number has recently been shown to be overly conservative. The Calabrese study had significant limitations as well as serious methodological problems related to tracer detection limits (Calabrese and Stanek, 1991; Stanek and Calabrese, 1991). Calabrese, et al (1997) later published the results of a second pilot study that overcame some of the problems with the first study and produced a very different result. The average adult soil ingestion rate was estimated at 10 mg/day. The Hawley paper used several unsupported assumptions to derive an average adult soil ingestion rate of 61 mg/day (3.7 in attic, 0.56 in living space, and 57 outdoors). However, one key assumption – soil loading on hands – was later demonstrated to be grossly overestimated (Kissel et al, 1996, 1996a, 1998). Using measured soil loading values along with Hawley's original assumptions produces a revised estimate of average total (24 hour) adult soil ingestion of about 10 mg/day.

remove

For the adult lead model, a best estimate soil ingestion number was judged important in order to produce the most defensible CAOs. On the basis of the current best estimate, the default commercial/industrial worker daily soil ingestion rate should be 5 mg/day assuming that one half of the total daily intake occurs at work. To be conservative, an ingestion rate of 10 mg/day was used for both the pregnant worker and full-time outdoor worker scenarios in the adult lead models.

For the construction excavation worker, the higher value of 50 mg/day (USEPA, 1997) was used given the potential for higher soil intakes associated with construction work.

should be 100

Exposure Frequency and Duration: The adult lead model presumes quasi-steady state blood lead concentrations, which require intake over a sufficient duration for the blood lead concentration to become nearly constant over time. The minimum time span to which this model should be applied is 90 days with exposure no less frequently than once per week.

The exposure frequency was 250 days per year for both the pregnant and full-time workers. A dry day exposure frequency of 182 days per year was used for the construction excavation worker. The exposure duration for the adult lead modeling was 365 days per year based on the TRW recommendation for continuing long-term exposure.

5.3 CORRECTIVE ACTION OBJECTIVES FOR LEAD

The equations and variables used to calculate lead CAOs are shown on Tables 5-1 and 5-2. The CAO for lead is based on the lowest lead concentration calculated for either the pregnant worker, full-time outdoor worker, or construction excavation worker. Therefore, a CAO of 8,360 mg/kg lead is protective of all site workers based on the construction excavation worker scenario (i.e., this level is protective of pregnant worker (calculated CAO of 13,500 mg/kg) and full-time outdoor worker (calculated CAO of 30,400 mg/kg)).

↑ Absolutely not!

* * * * *

6.0 SUMMARY

This CAO Development Report has been prepared to address action levels to be considered during the CMS. Section 1.0 presents an overview of the report. Section 2.0 identified COPCs for both the human health, Section 3.0 identified toxicological information associated with the COPCs, and Sections 4.0 and 5.0 present the equations and input parameters for calculation of the CAOs. This chapter summarizes the results of the previous chapters.

6.1 SUMMARY OF MEDIUM-SPECIFIC ALLOWABLE CHEMICAL CONCENTRATIONS

Medium-specific risk-based allowable chemical concentrations were calculated for the protection of human health. Tables 6-1 and 6-2 present the results of this analysis for soil and groundwater, respectively. It should be noted in some cases that soil or groundwater levels for human health protection may exceed soil saturation and water solubility limitations; therefore, soil saturations and water solubilities are also provided in the summary tables. The following paragraphs provide further discussion on soil saturation and solubility limits for the COPCs.

6.2 SOIL AND GROUNDWATER SATURATION LIMITS

For some chemicals, calculated allowable concentrations may exceed the physical capacity of environmental media. For soil, that capacity is based on adsorptive limits of the soil particles and solubility limits of available soil moisture. For groundwater, the limit is the maximum solubility of the pure chemical in water. When media limits are reached, phase-separated substances may be present and potentially mobile. The phase separated (or free product) level then becomes the level of concern, since the predictive models used to assess chemical transport to a receptor are predicated on source concentrations at or below saturation.

Soil saturation concentrations were calculated according to the equation and variables presented on Table 6-3.

This equation takes into account the amount of chemical that is in the vapor phase in the pore spaces of the soil in addition to the amount dissolved in soil moisture and adsorbed to soil particles. Soil saturation values represent chemical-physical limits in soil and are not risk-based. Risk-based calculations for some compounds may indicate that exposure to free product would not likely present a risk to human health. However, since saturation represents the concentration at which soil moisture and air are saturated with a chemical and the chemical is present as free product, exposure reaches the maximum possible at the saturation concentration. For this reason, soil saturation concentrations are used as an upper limit on CAOs. It should be noted that the

values calculated for soil saturation concentrations are dependent on soil moisture content and are subject to variation based on soil type. Therefore, the calculated soil saturation values presented in this report should be considered guidelines rather than definitive numerical limits.

For groundwater, the physical capacity limit is equal to the maximum solubility of the pure chemical in water. Solubility values for the COPCs are presented on Table 6-2. In addition, a check was performed to verify that the calculated groundwater levels based on groundwater exposure scenarios were compatible with the CAOs calculated for soil. Using chemical-specific partition coefficients (Kds) for chemicals in soil and groundwater, it was possible to estimate the groundwater concentration that would be in equilibrium with soil CAOs. Where risk-based groundwater levels exceeded the theoretical levels that would be partitioned from soil to groundwater, the values based on partitioning from soil to groundwater were selected.

* * * * *

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TABLES

Table 2-1
Screening Levels for Soil and Groundwater
AK Steel Kansas City Facility

Parameter	Soil		Groundwater	
	Ingestion SSL (a) mg/kg	Inhalation SSL (a) mg/kg	MCL(b) µg/L	Inhalation SSL (c) µg/L
VOCs				
Acetone	7,800	100,000	1,600 (d)	500,000,000
Benzene	22	0.80	5	350
2-Butanone	47,000 (h)	14,000 (h)	NA	NA
Carbon disulfide	7,800	720	1,600 (d)	1,190,000 (e)
Carbon tetrachloride	NA	NA	5	460
Chlorobenzene	1,600	390 (h)	100	NA
Chloroform	100	0.30	100	1,000
1,1-Dichloroethane	7,800	1,300	1,600 (d)	4,600,000
1,2-Dichloroethane	7	0.40	5	1,700
1,1-Dichloroethene	1	0.07	7	170
cis-1,2-Dichloroethene	780	1,200	70	3,500,000 (e)
trans-1,2-Dichloroethene	1,600	3,100	100	6,300,000 (e)
1,2-Dichloropropane	NA	NA	5	50,000
Ethylbenzene	7,800	400	700	169,000 (e)
2-Hexanone	3,100 (h)	-	NA	NA
4-Methyl-2-pentanone	6,300 (h)	-	1,300 (d)	-
Methylene chloride	85	13	5	56,000
Styrene	16,000	1,500	100	310,000 (e)
Tetrachloroethene	12	11	5	1,600
Toluene	16,000	650	1,000	526,000 (e)
1,1,1-Trichloroethane	1,600 (h)	1,200	200	1,330,000 (e)
1,1,2-Trichloroethane	11	1	5	3,300
Trichloroethene	58	5	5	8,800
Vinyl acetate	NA	NA	16,000 (d)	4,700,000
Vinyl chloride	0.3	0.03	2	90
Xylenes	160,000	410	10,000	161,000 (e)
SVOCs				
Acenaphthene	4,700	-	NA	NA
Acenaphthylene	-	-	NA	NA
Anthracene	23,000	-	NA	NA
Benzo(a)anthracene	0.9	670	NA	NA
Benzo(a)pyrene	0.09	67	0.2	-
Benzo(b)fluoranthene	0.9	670	0.09 (d)	-
Benzo(g,h,i)perylene	-	-	NA	NA
Benzo(k)fluoranthene	9	6,700	0.9 (d)	-
Bis(2-ethylhexyl)phthalate	46	31,000	6	-
Butylbenzylphthalate	16,000	930	NA	NA
4-Chloroaniline	NA	NA	63 (d)	-
Chrysene	88	67,000	9 (d)	-
Dibenzo(a,h)anthracene	0.09	67	NA	NA
Dibenzofuran	310 (h)	-	NA	NA
2,4-Dimethylphenol	NA	NA	310 (d)	-
Fluoranthene	3,100	-	630 (d)	-
Fluorene	3,100	-	NA	NA
Indeno(1,2,3-cd)pyrene	0.9	670	NA	NA
Isophorone	NA	NA	71 (d)	-
2-Methylnaphthalene	1,600 (h)	-	NA	NA
2-Methylphenol	NA	NA	780 (d)	-
4-Methylphenol	390 (h)	-	78 (d)	-
Naphthalene	1,600 (h)	180 (h)	310 (d)	-
Phenanthrene	-	-	-	-
Phenol	47,000	-	9,400 (d)	-
Pyrene	2,300	-	470 (d)	-

Table 2-1 (continued)
Screening Levels for Soil and Groundwater
AK Steel Kansas City Facility

Parameter	Soil		Groundwater	
	Ingestion SSL (a) mg/kg	Inhalation SSL (a) mg/kg	MCL(b) µg/L	Inhalation SSL (c) µg/L
Metals				
Arsenic	0.4	750	50	-
Barium	5,500	690,000	2,000	-
Cadmium	78	1,800	5	-
Chromium, total	(f)	(f)	100	-
Chromium, trivalent	120,000 (h)	-	NA	NA
Lead	400	-	15	-
Mercury	23	10	2	-
Selenium	390	-	50	-
Silver	390	-	100 (g)	-

Notes:

Dashes indicates value was not available.

NA indicates that the chemical was not detected in that medium.

(a) USEPA, 1996b

(b) USEPA, 1998

(c) Values were calculated from Soil Inhalation SSLs using the Soil Screening Level Partitioning Equation for Migration to Ground Water (USEPA, 1996a).

(d) No MCL was available for this chemical, therefore screening level was calculated using a risk-based equation for ingestion of drinking water.

(e) Screening level represents the solubility limit.

(f) Total Chromium detected in soil was screened as Trivalent Chromium (see text).

(g) Secondary Standard

(h) SSL was either calculated because it was not listed in USEPA, 1996b or recalculated due to updated toxicity values.

Table 2-2
Chemicals of Potential Concern (COPC)
AK Steel Kansas City Facility

	Surface	Groundwater
VOCs		
Benzene	X	X
1,2-Dichloroethane	X	X
1,1-Dichloroethene	X	X
cis-1,2-Dichloroethene	X	X
trans-1,2-Dichloroethene	X	X
Methylene Chloride	X	X
Tetrachloroethene	X	X
1,1,2-Trichloroethane	X	X
Trichloroethene	X	X
Vinyl Chloride	X	X
SVOCs		
Benzo(a)anthracene	X	X
Benzo(a)pyrene	X	X
Benzo(b)fluoranthene	X	X
Benzo(k)fluoranthene	X	X
bis(2-ethylhexyl)phthalate	X	X
Chrysene	X	X
Dibenzo(a,h)anthracene	X	X
Indeno(1,2,3-cd)pyrene	X	X
Metals		
Arsenic	X	X
Cadmium	X	X
Lead	X	X
Selenium	X	X

X Selected as a chemical of potential concern (COPC). In some cases, a COPC is not detected in both soil and groundwater, but is retained as a COPC in both media due to the potential for detection during future site development or corrective measure activities.

Table 3-1
Summary of Noncancer Toxicity Information
AK Steel Kansas City Facility

Chemical	Oral RfD (mg/kg/day)	Source	Toxic Effect of Concern	Air Conc. mg/m3	Inhalation RfD (a) (mg/kg/day)	Source	Toxic Effect of Concern	Dermal RfD (b) (mg/kg/day)	
VOCs									
Benzene	3E-03	STSC	Liver lesions		1.7E-03	STSC		3E-03	✓
1,2-Dichloroethane	3E-02	STSC			1.4E-03	STSC		3E-02	✓
1,1-Dichloroethene	9E-03	IRIS						9E-03	✓
cis-1,2-Dichloroethene	1E-02	HEAST	Increased alkaline phosphatase		8.6E-01	HEAST		1E-02	✓
trans-1,2-Dichloroethene	2E-02	IRIS						2E-02	✓
Methylene chloride	6E-02	IRIS						Liver toxicity	6E-02
Tetrachloroethene	1E-02	IRIS	Hepatotoxicity	1.4E-01	STSC	1E-02	✓		
1,1,2-Trichloroethane	4E-03	IRIS	Clinical serum chemistry	1E-01	3.0E-02	IRIS	Liver cell polymorphism	4E-03	✓
Trichloroethene	6E-03	STSC						6E-03	✓
Vinyl chloride	3E-03	IRIS	Liver cell polymorphism					3E-03	✓
SVOCs									
Benzo(a)anthracene	2E-02	IRIS	Increased liver weight					2E-02	✓
Benzo(a)pyrene									
Benzo(b)fluoranthene									
Benzo(k)fluoranthene									
Bis(2-ethylhexyl)phthalate									
Chrysene									
Dibenzo(a,h)anthracene									
Indeno(1,2,3-cd)pyrene									
Metals									
Arsenic	3E-04	IRIS	Hyperpigmentation, keratosis, possible vascular		5.7E-05	STSC		3E-04	✓
Cadmium - food	1E-03	IRIS						5E-05	✓
Lead	5E-03	IRIS	Clinical selenosis						
Selenium									

Notes:

HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)

IRIS - Integrated Risk Information System (www.epa.gov/iris/subst/index.html)

STSC - Superfund Technical Support Center value obtained from Region III Risk-Based Concentration Table (www.epa.gov/reg3hwmd/risk/index.htm)

(a) RfC (mg/m³) values were converted to RfD (mg/kg/day) values using the equation provided in the preface of HEAST.

(b) Dermal RfD based on Oral RfD except for Cadmium where a 5% absorption adjustment factor was used.

Blanks indicate that information was not available in IRIS, or from STSC.

Table 3-2
USEPA Carcinogen Classification*
AK Steel Kansas City Facility

CARCINOGEN CATEGORIES

- A Human carcinogen
- B Probable human carcinogen
- C Possible human carcinogen
- D Not classifiable
- E Evidence of noncarcinogenicity

WEIGHT-OF-EVIDENCE CLASSIFICATION MATRIX

Human Evidence	Animal Evidence				
	Sufficient	Limited	Inadequate	No Data	No Evidence
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Inadequate	B2	C	D	D	D
No Data	B2	C	D	D	E
No Evidence	B2	D	D	D	E

Note: The B category is subdivided into B1 and B2, with the strength of any available human data being the deciding factor.

* FR, 1986

Table 3-3

Summary of Cancer Toxicity Information AK Steel Kansas City Facility

Chemical	Weight of Evidence Classification (a)	Oral Slope Factor (mg/kg-day) ⁻¹	Source	Air Unit Risk (mg/m ³) ⁻¹	Inhalation Slope Factor (b) (mg/kg-day) ⁻¹	Source	Site of Tumor Oral/Inhalation	Dermal Slope Factor (d) (mg/kg-day) ⁻¹
VOCs								
Benzene	A	5.5E-02	IRIS	7.8E-03	2.7E-02	IRIS	Leukemia/Leukemia	5.5E-02
1,2-Dichloroethane	B2	9.1E-02	IRIS	2.6E-02	9.1E-02	IRIS	Hemangiosarcomas	9.1E-02
1,1-Dichloroethene	C	6.0E-01	IRIS	5.0E-02	1.8E-01	IRIS	Adrenal glands/Kidney	6.0E-01
cis-1,2-Dichloroethene	D							
trans-1,2-Dichloroethene	No Data							
Methylene chloride	B2	7.5E-03	IRIS	4.7E-04	1.6E-03	IRIS	Liver/Lung	7.5E-03
Tetrachloroethene	Under Review	5.2E-02	STSC		2.0E-03	STSC		5.2E-02
1,1,2-Trichloroethane	C	5.7E-02	IRIS	1.6E-02	5.6E-02	IRIS	Liver/ILiver	5.7E-02
Trichloroethene	Under Review	1.1E-02	STSC		6.0E-03	STSC		1.1E-02
Vinyl chloride	A	7.2E-01	IRIS	4.4E-03	1.5E-02	IRIS	Liver/Liver	7.2E-01
SVOCs								
Benzo(a)anthracene	B2	7.3E-01	STSC		3.1E-01	(c)	Forestomach, larynx, esophagus	7.3E-01
Benzo(a)pyrene	B2	7.3E+00	IRIS		3.1E+00	STSC		7.3E+00
Benzo(b)fluoranthene	B2	7.3E-01	STSC		3.1E-01	(c)		7.3E-01
Benzo(k)fluoranthene	B2	7.3E-02	STSC		3.1E-02	(c)		7.3E-02
Bis(2-ethylhexyl)phthalate	B2	1.4E-02	IRIS		1.4E-02	STSC	Liver	1.4E-02
Chrysene	B2	7.3E-03	STSC		3.1E-03	(c)		7.3E-03
Dibenzo(a,h)anthracene	B2	7.3E+00	STSC		3.1E+00	(c)		7.3E+00
Indeno(1,2,3-cd)pyrene	B2	7.3E-01	STSC		3.1E-01	(c)		7.3E-01
Metals								
Arsenic	A	1.5E+00	IRIS	4.3E+00	1.5E+01	IRIS	Skin/Lung	1.5E+00
Cadmium	B1			1.8E+00	6.3E+00	IRIS	Lung, trachea	
Lead	B2							
Selenium	D							

Notes:

HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)

IRIS - Integrated Risk Information System (www.epa.gov/iris/subst/index.html)STSC - Superfund Technical Support Center value obtained from Region III Risk-Based Concentration Table (www.epa.gov/reg3hwmrd/risk/index.htm)

(a) Weight of evidence classifications were taken from IRIS.

(b) Unit risk values [1/(mg/m³)] were converted to inhalation slope factors using the equation provided in the preface of HEAST.

(c) Based on Toxicity Equivalency Factors (TEFs) adjustment to benzo(a)pyrene slope factor as follows (USEPA, 1993):

1.0 for dibenzo(a,h)anthracene

0.01 for benzo(k)fluoranthene

0.001 for chrysene

0.1 for remaining listed PAHs

(d) Dermal slope factor based on oral slope factor unless noted.

Blanks indicate that information was not available in IRIS or from STSC.

Table 4-1
Formula for Allowable Chemical Concentrations in Soil
Based on Carcinogenic Effects
AK Steel Kansas City Facility

Equation:

$$Cs = \frac{TR \times BW \times AT}{EF \times ED \times [(SFo \times AAF \times FI \times IR \times UC) + (SFd \times SA \times AF \times ABS \times UC) + (SFi \times IRi \times ET)(1/PEF + 1/VF)]}$$

Where:

General Terms

Cs = Chemical concentration in soil (mg/kg)
 TR = Target risk level (unitless)
 BW = Body weight (kg)
 AT = Averaging time (days)
 EF = Exposure frequency (days/year)
 ED = Exposure duration (years)

Ingestion Terms

SFo = Oral slope factor (mg/kg-day)⁻¹
 AAF = Absorption adjustment factor (unitless)
 IR = Ingestion rate (mg soil/day)
 FI = Fraction ingested from contaminated source (unitless)
 UC = Unit conversion (10⁻⁶ kg/mg)

Dermal Terms

SFd = Dermal slope factor
 UC = Unit conversion (10⁻⁶ kg/mg)
 SA = Surface area available for contact (cm²/event)
 AF = Soil to skin adherence factor (mg/cm³)
 ABS = Absorption factor (unitless)

Inhalation Terms

SFi = Inhalation slope factor
 IRi = Inhalation rate (m³/hr)
 ET = Exposure time (hr/day)
 PEF = Particulate emission factor (m³/kg)
 VF = Volatilization factor

Facility Maintenance Worker Variable Values

TR = 1E-05 A target risk of 1E-04 is also used for situations where multiple chemicals are not present
 BW = 70 kg (USEPA, 1989)
 AT = 25550 days for cancer effects [70 years (lifetime) x 365 days/year]
 EF = 250 days/year (USEPA, 1991)
 ED = 25 years (USEPA, 1991)

AAF = 0.29 Carcinogenic PAHs
 1 For all other chemicals

FI = 1 (assumed 100 percent from contaminated source)

IRo = 50 mg/day (USEPA, 1997b)

UC = 1E-06 kg/mg

SA = 3,160 cm² (mean body part specific surface areas - forearms, hands, and head of adult male USEPA, 1997)

AF = 0.04 mg/cm² (see Table 4-3) *no . 2*

ABS = 0.01 VOCs and metals *no*
see SSL guidance
 0.014 PAHs *no*
 0.1 SVOCs *no*

IRi = 1.5 m³/hr (mean value for outdoor worker - moderate activity) (USEPA, 1997)

ET = 8 hr/day

PEF = 3.85E+07 m³/kg (see Table 4-4)

VF = -- Chemical Specific (see Table 4-5)

Table 4-1 (continued)
Formula for Allowable Chemical Concentrations in Soil
Based on Carcinogenic Effects
AK Steel Kansas City Facility

Construction Worker

TR =	1E-05	A target risk of 1E-04 is also used for situations where multiple chemicals are not present n ^o
BW =	70 kg	(USEPA, 1989)
AT =	25550 days	for cancer effects [70 years (lifetime) x 365 days/year]
EF =	182 dry days/year	(see text USEPA, 1988; USEPA, 1991)
ED =	1 year	
AAf =	0.29	Carcinogenic PAHs
	1	For all other chemicals
FI =	1	(assumed 100 percent from contaminated source)
IRo =	330 mg/day	
UC =	1E-06 kg/mg	
SA =	3,160 cm ²	(mean body part specific surface areas - forearms, hands, and head of adult male USEPA, 1997)
AF =	0.22 mg/cm ²	(see Table 4-3)
ABS =	0.01	VOCs and metals
	0.014	PAHs
	0.1	SVOCs
IRi =	2.5 m ³ /hr	(mean value for outdoor worker - heavy activity) (USEPA, 1997)
ET =	8 hr/day	
PEF =	5.33E+06 m ³ /kg	(see Table 4-4)
VF =	--	Chemical Specific (see Table 4-5)

Table 4-2
Formula for Allowable Chemical Concentrations in Soil
Based on Noncarcinogenic Effects
AK Steel Kansas City Facility

Equation:

$$Cs = \frac{THQ \times BW \times AT}{EF \times ED \times [(AAF \times FI \times IR \times UC / RfDo) + (SA \times AF \times ABS \times UC / RfDd) + (IRi \times ET)(1/PEF + 1/VF)/RfDi]}$$

Where:

General Terms

Cs = Chemical concentration in soil (mg/kg)
 THQ = Target hazard quotient (unitless)
 BW = Body weight (kg)
 AT = Averaging time (days)
 EF = Exposure frequency (days/year)
 ED = Exposure duration (years)

Ingestion Terms

RfDo = Oral reference dose (mg/kg/day)
 AAF = Absorption adjustment factor (unitless)
 IR = Ingestion rate (mg soil/day)
 FI = Fraction ingested from contaminated source (unitless)
 UC = Unit conversion (10^{-6} kg/mg)

Dermal Terms

RfDd = Dermal reference dose (mg/kg/day)
 UC = Unit conversion (10^{-6} kg/mg)
 SA = Surface area available for contact (cm^2/event)
 AF = Soil to skin adherence factor (mg/cm^3)

Inhalation Terms

ABS = Absorption factor (unitless)
 RfDi = Inhalation reference dose (mg/kg/day)
 IRi = Inhalation rate (m^3/hr)
 ET = Exposure time (hr/day)
 PEF = Particulate emission factor (m^3/kg)
 Volatilization factor

Facility Maintenance Worker Variable Values

THI = 0.3 A reference dose of 1.0 is also used for situations where multiple chemicals are not present
 BW = 70 kg (USEPA, 1989)
 AT = 9,125 days for noncancer effects, [25 years (ED) x 365 days/year] USEPA, 1989
 EF = 250 days/year (USEPA, 1991)
 ED = 25 years (USEPA, 1991)
 AAF = 0.29 Carcinogenic PAHs
 1 For all other chemicals
 FI = 1 (assumed 100 percent from contaminated source)
 IRo = 50 mg/day (USEPA, 1997b)
 UC = $1\text{E-}06$ kg/mg
 SA = $3,160 \text{ cm}^2$ (mean body part specific surface areas - forearms, hands, and head of adult male USEPA, 1997)
 AF = $0.04 \text{ mg}/\text{cm}^2$ (see Table 4-3)
 ABS = 0.01 VOCs and metals
 0.014 PAHs
 0.1 SVOCs
 IRi = $1.5 \text{ m}^3/\text{hr}$ (mean value for outdoor worker - moderate activity) (USEPA, 1997)
 ET = 8 hr/day
 PEF = $3.85\text{E}+07 \text{ m}^3/\text{kg}$ (see Table 4-4)
 VF = -- Chemical Specific (see Table 4-5)

Table 4-2 (continued)
Formula for Allowable Chemical Concentrations in Soil
Based on Noncarcinogenic Effects
AK Steel Kansas City Facility

Construction Worker

THQ =	0.3 A reference dose of 1.0 is also used for situations where multiple chemicals are not present
BW =	70 kg (USEPA, 1989)
AT =	365 days for noncancer effects, {1 years (ED) x 365 days/year]
EF =	182 dry days/year (see text USEPA, 1988; USEPA, 1991)
ED =	1 year
AAf =	0.29 Carcinogenic PAHs
	1 For all other chemicals
FI =	1 (assumed 100 percent from contaminated source)
IRo =	330 mg/day
UC =	1E-06 kg/mg
SA =	3,160 cm ² (mean body part specific surface areas - forearms, hands, and head of adult male USEPA, 1997)
AF =	0.22 mg/cm ² (see Table 4-3)
ABS =	0.01 VOCs and metals
	0.014 PAHs
	0.1 SVOCs
IRi =	2.5 m ³ /hr (mean value for outdoor worker - heavy activity) (USEPA, 1997)
ET =	8 hr/day
PEF =	5.33E+06 m ³ /kg (see Table 4-4)
VF =	-- Chemical Specific (see Table 4-5)

Table 4-3
Population Activity-Specific Adherence Factors
AK Steel Kansas City Facility

Equation:

$$AF_{ave} = \frac{(SA_e \times AF_e) + (SA_a \times AF_a) + (SA_h \times AF_h)}{SA_e + SA_a + SA_h}$$

Where:

- AF_{ave} = Average adherence factor (mg/cm²)
- SA_e = Surface area of the head (cm²)
- AF_e = Adherence factor for the head (mg/cm²)
- SA_a = Surface area of the arms or forearms (cm²)
- AF_a = Adherence factor for the arms or forearms (mg/cm²)
- SA_h = Surface area of the hands (cm²)
- AF_h = Adherence factor for the hands (mg/cm²)

Variables:

SA _e (cm ²)	AF _e (mg/cm ²)	SA _a (cm ²)	AF _a (mg/cm ²)	SA _h (cm ²)	AF _h (mg/cm ²)	AF _{ave} (mg/cm ²)
Full-Time Outdoor Worker (a)						
1180	0.0021	1140	0.005	840	0.15	0.04
Temporary Excavation Worker (b)						
1180	0.32	1140	0.2	840	0.1	0.22

Notes:

NA - Not Applicable

(a) Individual body part adherence factors based on Groundskeeper No. 1 field study group (USEPA, 1997).

(b) Individual body part adherence factors based on Utility Worker No. 1 field study group (USEPA, 1997).

Table 4-4
Particulate Emission Factor Equation
 AK Steel Kansas City Facility

Equation:

$$PEF = 1 / (D \times RF \times CF)$$

Where:

PEF = Particulate emission factor (m³/Kg)

D = Dust concentration (ug/m³)

RF = Respirable fraction (unitless)

CF = Conversion factor (1E-09 Kg/μg)

D = 26 ug/m³, full-time outdoor worker (MDNR, 1999)

D = 257 ug/m³, construction worker (GRI, 1988)

RF = 1 for outdoor worker

RF = 0.73 for construction worker (HRI, 1995)

Variable Values:

Population	D (ug/m ³)	RF (unitless)	CF (kg/μg)	PEF (m ³ /kg)
Facility Maintenance Worker	26	1	1.0E-09	3.85E+07
Construction Worker	257	0.73	1.0E-09	5.33E+06

Table 4-5
Volatilization Factor
 AK Steel Kansas City Facility

Equation:

$$VF = \frac{Q/C \times (3.14 \times Da \times T)^{0.5} \times UC}{(2 \times Pb \times Da)}$$

Where:

$$Da = \frac{[(Oa^{3.33} \times Di \times H' + Ow^{3.33} \times Dw) / n^2]}{Pb \times Kd + Ow + Oa \times H'}$$

Where:

- VF = Soil volatilization factor (m³/Kg)
 Q/C = Inverse of the mean concentration at the center of a 0.5 acre square source (g/m²-s per Kg/m³)
 Da = Apparent diffusivity (cm²/s)
 T = Exposure interval (s)
 UC = Emission (m²/cm²)
 Pb = Dry soil bulk density (g/cm³)
 Oa = Air-filled soil porosity (L-air/L-soil)
 Di = Diffusion coefficient in air (cm²/s)
 H' = Henry's law constant (unitless)
 Ow = Water-filled soil porosity (L-air/L-soil)
 Dw = Diffusion coefficient in water (cm²/s)
 n = Total soil porosity (L-pore/L-soil)
 Kd = Soil-water sorption coefficient (g-water/g-soil) (Koc x foc)
 Koc = Carbon-water sorption coefficient (g-water/g-carbon)
 foc = Fraction organic carbon (unitless)

Variables:

- Q/C = 41.95 g/m²-sec per Kg/m³ (default based on a 30-acre site in Lincoln, NE)
 T = 7.88E+08 s (25 years exposure duration for full time worker)
 3.15E+07 s (1 year exposure duration for construction worker)
 UC = 1E-04 cm³-Kg/m³-g
 Pb = 1.96 g/cm³ (default for clayey soil in-situ)
 Oa = 0.17 L/L (n-Ow)
 Di = Chemical-specific (USEPA, 1996)
 H' = Chemical-specific (HRI, 1997)
 Ow = 0.38 L/L (site-specific value)
 Dw = Chemical-specific (USEPA, 1996)
 n = 0.55 L/L (Freeze & Cherry 1979)
 Kd = Chemical-specific (calculated)
 Koc = Chemical-specific
 foc = 0.00767 unitless (site-specific value)

Full Time Worker Chemical	H' (unitless)	Koc cm ³ /g	Kd cm ³ /g	Di (cm ² /s)	Dw (cm ² /s)	Da (cm ² /s)	VF (m ³ /Kg)
Benzene	2.28E-01	5.89E+01	4.52E-01	8.80E-02	9.80E-06	1.4E-04	4.5E+03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.33E-01	1.04E-01	9.90E-06	6.0E-05	6.9E+03
1,1-Dichloroethene	1.07E+00	5.89E+01	4.52E-01	9.00E-02	1.04E-05	6.0E-04	2.2E+03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	2.72E-01	7.36E-02	1.13E-05	1.2E-04	4.9E+03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	4.03E-01	7.07E-02	1.19E-05	2.0E-04	3.8E+03
Methylene chloride	8.98E-02	1.17E+01	8.97E-02	1.01E-01	1.17E-05	1.5E-04	4.4E+03
Tetrachloroethene	7.54E-01	1.55E+02	1.19E+00	7.20E-02	8.20E-06	1.7E-04	4.0E+03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	3.84E-01	7.80E-02	8.80E-06	2.4E-05	1.1E+04
Trichloroethene	4.22E-01	1.66E+02	1.27E+00	7.90E-02	9.10E-06	1.0E-04	5.3E+03
Vinyl chloride	1.11E+00	1.86E+01	1.43E-01	1.06E-01	1.23E-06	1.3E-03	1.5E+03

Table 4-5 (continued)
Volatilization Factor
 AK Steel Kansas City Facility

Construction Worker Chemical	H' (unitless)	Koc cm³/g	Kd cm³/g	Di (cm²/s)	Dw (cm²/s)	Da (cm²/s)	VF (m³/Kg)
Benzene	2.28E-01	5.89E+01	4.52E-01	8.80E-02	9.80E-06	1.4E-04	9.0E+02
1,2-Dichloroethane	4.01E-02	1.74E+01	1.33E-01	1.04E-01	9.90E-06	6.0E-05	1.4E+03
1,1-Dichloroethene	1.07E+00	5.89E+01	4.52E-01	9.00E-02	1.04E-05	6.0E-04	4.3E+02
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	2.72E-01	7.36E-02	1.13E-05	1.2E-04	9.7E+02
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	4.03E-01	7.07E-02	1.19E-05	2.0E-04	7.5E+02
Methylene chloride	8.98E-02	1.17E+01	8.97E-02	1.01E-01	1.17E-05	1.5E-04	8.8E+02
Tetrachloroethene	7.54E-01	1.55E+02	1.19E+00	7.20E-02	8.20E-06	1.7E-04	8.1E+02
1,1,2-Trichloroethane	3.74E-02	5.01E+01	3.84E-01	7.80E-02	8.80E-06	2.4E-05	2.2E+03
Trichloroethene	4.22E-01	1.66E+02	1.27E+00	7.90E-02	9.10E-06	1.0E-04	1.0E+03
Vinyl chloride	1.11E+00	1.86E+01	1.43E-01	1.06E-01	1.23E-06	1.3E-03	3.0E+02

Table 4-6
Formula for Allowable Chemical Concentrations in Groundwater
AK Steel Kansas City Facility

Equations:

cancer effects:

$$C_w = \frac{TR \times BW \times AT}{ED \times [(SF_d \times SA \times K_p \times EF_d \times ET_d \times UC) + (SFI \times IRI \times EFI \times ET_i \times K_d / VF)]}$$

noncancer effects:

$$C_w = \frac{THQ \times BW \times AT}{ED \times [(RfD_d^{-1} \times SA \times K_p \times EF_d \times ET_d \times UC) + (RfDi^{-1} \times IRI \times EFI \times ET_i \times K_d / VF)]}$$

Where:

General Terms

Cw = Chemical concentration in water (mg/L)
 TR = Target risk level (unitless)
 THQ = Target hazard quotient (unitless)
 BW = Body weight (kg)
 AT = Averaging time (days)
 ED = Exposure duration (years)

Dermal Terms

SF_d = Chemical-specific dermal slope factor (mg·kg/day)⁻¹
 RfD_d = Chemical-specific dermal reference dose (mg·kg/day)
 UC = Unit conversion (10⁻³ L/cm)
 SA = Surface area available for contact (cm²/event)
 K_p = Dermal permeability constant (cm/hr)
 EF_d = Dermal exposure frequency (events per year)
 ET_d = Dermal exposure Time (hr/day)

Inhalation Terms

SFI = Chemical-specific inhalation slope factor (mg·kg/day)⁻¹
 RfDi = Chemical-specific inhalation reference dose (mg·kg/day)
 IRI = Inhalation rate (m³/hr)
 ET_i = Inhalation exposure time (hr/day)
 VF = Chemical-specific volatilization factor (m³/kg)
 EF_i = Inhalation exposure frequency (days per year)
 K_d = Chemical-specific soil to water partition coefficient (L/kg)

Facility Maintenance Worker Variable Values

TR = 1E-05 A target risk of 1E-04 is also used for situations where multiple chemicals are not present
 THQ = 0.3 A reference dose of 1.0 is also used for situations where multiple chemicals are not present
 BW = 70 kg (USEPA, 1989)
 AT = 25550 days for cancer effects [70 years (lifetime) x 365 days/year]
 9125 days for noncancer effects [25 years x 365 days/year]
 ED = 25 years (USEPA, 1991)

 UC = I.C. (I.C. = incomplete; dermal pathway is incomplete for full-time outdoor worker)
 SA = I.C.
 K_p = I.C.
 EF_d = I.C.
 ET_d = I.C.

 IRI = 1.5 m³/hr (mean value for outdoor worker - moderate activity) (USEPA, 1997)
 ET_i = 8 hr/day
 VF = -- Chemical specific (see Table 4-5)
 EF_i = 250 days per year
 K_d = -- Chemical specific (see Table 4-7)

Table 4-6 (continued)
Formula for Allowable Chemical Concentrations in Groundwater
AK Steel Kansas City Facility

Construction Worker

TR =	1E-05	A target risk of 1E-04 is also used for situations where multiple chemicals are not present
THQ =	0.3	A reference dose of 1.0 is also used for situations where multiple chemicals are not present
BW =	70 kg	(USEPA, 1989)
AT =	25550 days for cancer effects [70 years (lifetime) x 365 days/year]	
	365 days for noncancer effects [1 years x 365 days/year]	
ED =	1 years	(USEPA, 1991)
UC =	1E-03	L/cm ³
SA =	6,310	cm ² (mean body part specific surface areas - hands, forearms, lower legs, and feet of adult)
Kp =	--	Chemical specific (see Table 4-7)
EFd =	25 events/year	(estimate conservative contact with water in an excavation 25 times annually)
ETd	8 hr/day	
IRi =	2.5 m ³ /hr	(mean value for outdoor worker - moderate activity) (USEPA, 1997)
ETi =	8 hr/day	
VF =	--	Chemical Specific (see Table 4-5)
EFi =	182 dry days per year	(see text, USEPA, 1988; USEPA, 1991)
Kd =	--	Chemical Specific (see Table 4-5)

Table 4-7
Dermal Permeability Constant (Kp)
 AK Steel Kansas City Facility

Chemical	Kp -measured	Kp - Predicted	Kp Water	Selected Value
VOCs				
	(cm/hr)	(cm/hr)		
Benzene	1.00E-01	2.10E-02		1.00E-01
1,2-Dichloroethane		5.30E-03		5.30E-03
1,1-Dichloroethene		1.60E-02		1.60E-02
cis-1,2-Dichloroethene		1.00E-02		1.00E-02
trans-1,2-Dichloroethene		1.00E-02		1.00E-02
Methylene chloride		4.50E-03		4.50E-03
Tetrachloroethene	4.00E-01	4.80E-02		4.00E-01
1,1,2-Trichloroethane		8.40E-03		8.40E-03
Trichloroethene	2.00E-01	1.60E-02		2.00E-01
Vinyl chloride		7.30E-03		7.30E-03
SVOCs				
Benzo(a)anthracene		8.10E-01		8.10E-01
Benzo(a)pyrene		1.20E+00		1.20E+00
Benzo(b)fluoranthene		1.20E+00		1.20E+00
Benzo(k)fluoranthene			1.00E-03	1.00E-03
Bis(2-ethylhexyl)phthalate		3.30E-02		3.30E-02
Chrysene		8.10E-01		8.10E-01
Dibenzo(a,h)anthracene		2.70E+00		2.70E+00
Indeno(1,2,3-cd)pyrene		1.90E+00		1.90E+00
Metals				
Arsenic			1.00E-03	1.00E-03
Cadmium - food			1.00E-03	1.00E-03
Lead			1.00E-03	1.00E-03
Selenium			1.00E-03	1.00E-03

Table 5-1
Blood Lead Concentration Calculations for Pregnant Worker
AK Steel Kansas City Facility

Equations*:

$$CAO = PbS = \frac{(PbBac - PbBo)}{BKSF \times IRs \times AFs}$$

$$PbBac = \frac{PbB_{fetal}}{GSDi^{1.645} \times R}$$

Results:

Pregnant Worker Comparison	13,500 mg/kg
----------------------------	--------------

Where:

PbB_{fetal} = 95th percentile blood lead concentration (PbB) of a the fetus in a population of pregnant women exposed to lead-contaminated soil and dust from the site ($\mu\text{g/dL}$)

$PbBac$ = Geometric mean PbB of workers exposed to lead-contaminated soil and dust at the site ($\mu\text{g/dL}$)

$PbBo$ = Geometric mean PbB in adults age 20-49 not exposed to lead-contaminated soil and dust from the site ($\mu\text{g/dL}$)

PbS = Corrective action objective concentration of lead in soil (mg/kg)

$BKSF$ = Biokinetic slope factor ($\mu\text{g/dL}$ increase in PbB per $\mu\text{g/day}$ lead absorbed)

IRs = Mean daily intake rate of soil (g/day)

Where: $IRs = IRsd \times FS \times (EF / ED)$

$IRsd$ = Ingestion rate of soil and dust from the site (g/day)

FS = Fraction of soil ingested from site.

EF = Exposure frequency (days/year)

ED = Exposure duration (days/year)

AFs = Absolute absorption fraction (bioavailability) of lead in soil (unitless)

$GSDi$ = Individual geometric standard deviation of PbB among a population of adults exposed to lead-contaminated soil and dust at the site (unitless)

R = Mean ration of fetal to maternal blood lead (unitless)

Variable Values:

Pregnant Worker

PbB_{fetal} = 10 $\mu\text{g/dL}$
 $PbBo$ = 2 $\mu\text{g/dL}$ Bowers & Cohen, 1998
 $BKSF$ = 0.4 $\mu\text{g/dL}$ increase in PbB per $\mu\text{g/day}$ lead absorbed
 $IRsd$ = 0.01 g/day (Calbrese, 1997) \leftarrow no
 FS = 0.5
 EF = 250 days/year
 ED = 365 days/year
 AFs = 0.12
 $GSDi$ = 1.8
 R = 0.9

* (USEPA, 1996)

Table 5-2 Blood Lead Concentration Calculations for Site Workers AK Steel Kansas City Facility

Equations*:

$$CAO = PbS = \frac{(PbBac - PbBo)}{BKSF \times IRs \times AFs}$$

$$PbBac = \frac{PbB_{95}}{GSDi^{1.645}}$$

Results:

Full-time Outdoor Worker	30,400 mg/kg
Construction Excavation Worker	8,360 mg/kg

← need pregnant

Where:

PbB_{95} = 95th percentile blood lead concentration (PbB) of a population of workers exposed to lead-contaminated soil and dust from the site ($\mu\text{g/dL}$)

$PbBac$ = Geometric mean PbB of workers exposed to lead-contaminated soil and dust at the site ($\mu\text{g/dL}$)

$PbBo$ = Geometric mean PbB in adults age 20-49 not exposed to lead-contaminated soil and dust from the site ($\mu\text{g/dL}$)

PbS = Corrective action objective concentration of lead in soil (mg/kg)

$BKSF$ = Biokinetic slope factor ($\mu\text{g/dL}$ increase in PbB per $\mu\text{g/day}$ lead absorbed)

IRs = Mean daily intake rate of soil (g/day)

Where: $IRs = IRsd \times FS \times (EF / ED)$

$IRsd$ = Ingestion rate of soil and dust from the site (g/day)

FS = Fraction of soil ingested from site

EF = Exposure frequency (days/year)

ED = Exposure duration (days/year)

AFs = Absolute absorption fraction (bioavailability) of lead in soil (unitless)

$GSDi$ = Individual geometric standard deviation of PbB among a population of adults exposed to lead-contaminated soil and dust at the site (unitless)

Variable Values:

Full Time Outdoor Worker:

PbB_{95} = 20 $\mu\text{g/dL}$ (ATSDR, 1998)
 $PbBo$ = 2.6 $\mu\text{g/dL}$ NHANES (Brody et al, 1994)
 $BKSF$ = 0.4 $\mu\text{g/dL}$ increase in PbB per $\mu\text{g/day}$ lead absorbed
 $IRsd$ = 0.01 g/day (Calabrese, 1997)
 EF = 250 dry days/year (see text, USEPA, 1988; USEPA, 1991)
 ED = 365 days/year
 AFs = 0.12
 $GSDi$ = 1.8
 FS = 0.5

Construction Excavation Worker:

PbB_{95} = 20 $\mu\text{g/dL}$ (ATSDR, 1998)
 $PbBo$ = 2.6 $\mu\text{g/dL}$ NHANES (Brody et al, 1994)
 $BKSF$ = 0.4 $\mu\text{g/dL}$ increase in PbB per $\mu\text{g/day}$ lead absorbed
 $IRsd$ = 0.05 g/day (USEPA, 1997)
 EF = 182 days/year
 ED = 365 days/year
 AFs = 0.12
 $GSDi$ = 1.8
 FS = 0.5

* (USEPA, 1996)

Table 6-1
Allowable Chemical Concentrations in Soil
Human Health Evaluation
 AK Steel Kansas City Facility

Chemical	Target Cancer Risk Level = 1E-05; Hazard Index = 0.3						Target Cancer Risk Level = 1E-04; Hazard Index = 1					
	Cs (mg/kg) Full Time Outdoor Worker		Cs (mg/kg) Construction Worker		Soil Saturation (mg/kg)	Allowable Soil Concentration (mg/Kg)	Cs (mg/kg) Full Time Outdoor Worker		Cs (mg/kg) Construction Worker		Soil Saturation (mg/kg)	Allowable Soil Concentration (mg/Kg)
	Noncancer Effects	Cancer Effects	Noncancer Effects	Cancer Effects			Noncancer Effects	Cancer Effects	Noncancer Effects	Cancer Effects		
VOCs												
Benzene	19	38	3.2	159	1,164	3.2	64	382	10.6	1,586	1,164	10.6
1,2-Dichloroethane	24	17	4.0	72	2,819	4.0	82	175	13.5	724	2,819	13.5
1,1-Dichloroethene	5,383	2.8	1,125	11.5	1,662	2.8	17,942	27.9	3,750	115.5	1,662	27.9
cis-1,2-Dichloroethene	5,981	--	1,250	--	1,682	1,250	19,936	--	4,166	--	1,682	1,682
trans-1,2-Dichloroethene	11,962	--	2,500	--	3,969	2,500	39,872	--	8,333	--	3,969	3,969
Methylene chloride	7,614	603	1,314	2,525	3,797	603	25,381	6,025	4,379	25,252	3,797	3,797
Tetrachloroethene	1,164	333	200	1,466	290	200	3,880	3,326	667	14,660	290	290
1,1,2-Trichloroethane	2,392	44	500	183	2,570	44	7,974	440	1,667	1,830	2,570	440
Trichloroethene	3,588	200	750	833	1,654	200	11,962	2,004	2,500	8,325	1,654	1,654
Vinyl chloride	108	18	18	79	1,194	18	361	183	60	792	1,194	60
SVOCs												
Benzo(a)anthracene	--	239	--	1,258	29	29	--	2,390	--	12,578	29	29
Benzo(a)pyrene	--	24	--	126	13	13	--	239	--	1,258	13	13
Benzo(b)fluoranthene	--	239	--	1,258	14	14	--	2,390	--	12,578	14	14
Benzo(k)fluoranthene	--	2,390	--	12,578	7.5	7.5	--	23,899	--	125,778	7.5	7.5
Bis(2-ethylhexyl)phthalate	9,789	3,247	5,098	17,406	39,378	3,247	32,631	32,469	16,994	174,057	39,378	16,994
Chrysene	--	23,899	--	125,778	4.9	4.9	--	238,994	--	1,257,780	4.9	4.9
Dibenzo(a,h)anthracene	--	24	--	126	73	24	--	239	--	1,258	73	73
Indeno(1,2,3-cd)pyrene	--	239	--	1,258	0.59	0.59	--	2,390	--	12,578	0.59	0.59
Metals												
Arsenic	179	35	37	175		35	598	351	125	1,749		125
Cadmium - food	380	1,456	79	4,157		79	1,266	14,558	262	41,571		262
Lead	--	--	--	--		8,360	--	--	--	--		8,360
Selenium	2,990	--	625	--		625	9,968	--	2,083	--		2,083

Notes:

- Calculation of soil lead CAO is presented in Section 5.0
- Value was not calculated due to no reported RfDs and/or Slope Factors
- Cs = Allowable chemical concentration in soil.

→ An excess cancer risk of 1×10^{-5} and hazard index of 0.3 is based on areas where multiple chemicals are present in concentrations approaching the CAO. For areas where a single chemical is present at a concentration approaching a CAO an excess cancer risk of 1×10^{-4} and hazard index of 1 are appropriate for an industrial setting.

Table 6-2
Allowable Chemical Concentrations in Groundwater
Human Health Evaluation
 AK Steel Kansas City Facility

Chemical	Target Cancer Risk Level = 1E-05; Hazard Index = 0.3							Target Cancer Risk Level = 1E-04; Hazard Index = 1						
	Cw (mg/L) Full Time Outdoor Worker		Cw (mg/L) Construction Worker		GW in Equilibrium with Soil Cleanup Objectives (mg/L)	Solubility (mg/L)	Allowable Groundwater Concentration (mg/L)	Cw (mg/L) Full Time Outdoor Worker		Cw (mg/L) Construction Worker		GW in Equilibrium with Soil Cleanup Objectives (mg/L)	Solubility (mg/L)	Allowable Groundwater Concentration (mg/L)
	Noncancer Effects	Cancer Effects	Noncancer Effects	Cancer Effects				Noncancer Effects	Cancer Effects	Noncancer Effects	Cancer Effects			
VOCs														
Benzene	43	88	0.18	2.6	1.4	1,750	0.18	144	879	0.59	25.6	4.8	1,750	0.59
1,2-Dichloroethane	184	135	16.1	28	0.54	8,520	0.54	613	1,347	53.7	279	1.80	8,520	1.80
1,1-Dichloroethene	--	6.4	3.4	1.4	1.3	2,250	1.3	--	63.6	11.4	14.0	12.6	2,250	11.4
cis-1,2-Dichloroethene	--	--	6.1	--	340	3,500	6.1	--	--	20.2	--	458	3,500	20.2
trans-1,2-Dichloroethene	--	--	12.1	--	1,007	6,300	12	--	--	40.5	--	1,598	6,300	40
Methylene chloride	107,717	7,306	80.6	414	54	13,030	54	359,056	73,064	268.7	4,141	341	13,030	269
Tetrachloroethene	1,216	405	0.15	0.68	238	200	0.15	4,053	4,053	0.51	6.81	344	200	0.51
1,1,2-Trichloroethane	--	120	2.9	28	17	4,420	2.9	--	1,199	9.6	279	169	4,420	9.6
Trichloroethene	--	164	0.18	6.4	255	1,100	0.18	--	1,639	0.61	63.8	2,106	1,100	0.61
Vinyl chloride	807	167	2.5	2.7	2.6	2,760	2.5	2,691	1,674	8.2	26.9	8.6	2,760	8.2
SVOCs														
Benzo(a)anthracene	--	--	--	0.024	8.8.E+04	0.0094	0.0094	--	--	--	0.240	8.8.E+04	0.0094	0.0094
Benzo(a)pyrene	--	--	--	0.0016	9.9.E+04	0.00162	0.0016	--	--	--	0.0162	9.9.E+04	0.00162	0.0016
Benzo(b)fluoranthene	--	--	--	0.016	1.3.E+05	0.0015	0.0015	--	--	--	0.162	1.3.E+05	0.0015	0.0015
Benzo(k)fluoranthene	--	--	--	194.1	7.1.E+04	0.0008	0.0008	--	--	--	1,941.4	7.1.E+04	0.0008	0.0008
Bis(2-ethylhexyl)phthalate	--	--	3.7	30.7	3.8.E+08	0.34	0.34	--	--	12.3	306.8	2.0.E+09	0.34	0.34
Chrysene	--	--	--	2.4	1.5.E+04	0.0016	0.0016	--	--	--	24.0	1.5.E+04	0.0016	0.0016
Dibenzo(a,h)anthracene	--	--	--	0.00072	7.0.E+05	0.00249	0.00072	--	--	--	0.00719	2.1.E+06	0.00249	0.00249
Indeno(1,2,3-cd)pyrene	--	--	--	0.0102	1.6.E+04	0.000022	0.000022	--	--	--	0.1022	1.6.E+04	0.000022	0.000022
Metals														
Arsenic	--	--	1.8	9.4	--	--	1.8	--	--	6.1	94.5	--	--	6.1
Cadmium - food	--	--	6.1	--	--	--	6.1	--	--	20.2	--	--	--	20.2
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	30	--	--	--	30	--	--	101	--	--	--	101

Notes:

- The calculated groundwater concentrations (i.e., equations on Table 4-6) are compared to the groundwater concentration in equilibrium with calculated soil CAOs.

-- Value was not calculated due to no reported RfDs and/or Slope Factors, or not volatilized from soil.

Cs = Allowable chemical concentration in soil.

An excess cancer risk of 1×10^{-5} and hazard index of 0.3 is based on areas where multiple chemicals are present in concentrations approaching the CAO. For areas where a single chemical is present at a concentration approaching a CAO an excess cancer risk of 1×10^{-4} and hazard index of 1 are appropriate for an industrial setting.

Table 6-3
Calculation of Soil Saturation Concentrations
 AK Steel

Equation:

$$Csat = S / Pb \times [(Pb \times Kd) + Ow + (H' \times Oa)]$$

Where:

- Csat = Soil saturation (mg/Kg)
 S = Solubility (mg/L)
 Pb = Soil bulk density (Kg/L)
 Kd = Soil-water partitioning coefficient (L/Kg) = (Koc x foc)
 Koc = Carbon-water sorption coefficient (L-water/Kg-carbon)
 foc = Fraction organic carbon (unitless)
 Ow = Water-filled soil porosity (Lwater / Lsoil)
 H' = Henry's constant (dimensionless)
 Oa = Air-filled soil porosity (Lair / Lsoil)

Variable Values:

- S = Chemical-specific
 Pb = 1.96 (Kg/L) (default value for clayey soil measured in-situ)
 Kd = Calculated
 Koc = Chemical-specific
 foc = 0.00767 (unitless) (site-specific value)
 Ow = 0.38 (Lwater / Lsoil) (site-specific value)
 H' = Chemical-specific
 Oa = 0.17 (Lair / Lsoil) (site-specific value, where Ot - Ow = Oa, Ot = total porosity, 0.55, Freeze & Cherry, 1979)

Chemical	S (mg/L)	Koc (L/Kg)	Kd (L/Kg)	H' (unitless)	Csat' (mg/Kg)	Csat' (µg/Kg)
VOCs						
Benzene	1.75E+03	5.89E+01	4.52E-01	2.28E-01	1.16E+03	1.16E+06
1,2-Dichloroethane	8.52E+03	1.74E+01	1.33E-01	4.01E-02	2.82E+03	2.82E+06
1,1-Dichloroethene	2.25E+03	5.89E+01	4.52E-01	1.07E+00	1.66E+03	1.66E+06
cis-1,2-Dichloroethene	3.50E+03	3.55E+01	2.72E-01	1.67E-01	1.68E+03	1.68E+06
trans-1,2-Dichloroethene	6.30E+03	5.25E+01	4.03E-01	3.85E-01	3.97E+03	3.97E+06
Methylene chloride	1.30E+04	1.17E+01	8.97E-02	8.98E-02	3.80E+03	3.80E+06
Tetrachloroethene	2.00E+02	1.55E+02	1.19E+00	7.54E-01	2.90E+02	2.90E+05
1,1,2-Trichloroethane	4.42E+03	5.01E+01	3.84E-01	3.74E-02	2.57E+03	2.57E+06
Trichloroethene	1.10E+03	1.66E+02	1.27E+00	4.22E-01	1.65E+03	1.65E+06
Vinyl chloride	2.76E+03	1.86E+01	1.43E-01	1.11E+00	1.19E+03	1.19E+06
SVOCs						
Benzo(a)anthracene	9.40E-03	398000	3.05E+03	1.37E-04	2.87E+01	2.87E+04
Benzo(a)pyrene	1.62E-03	1020000	7.82E+03	4.63E-05	1.27E+01	1.27E+04
Benzo(b)fluoranthene	1.50E-03	1230000	9.43E+03	4.55E-03	1.42E+01	1.42E+04
Benzo(k)fluoranthene	8.00E-04	1230000	9.43E+03	3.40E-05	7.55E+00	7.55E+03
Bis(2-ethylhexyl)phthalate	3.40E-01	15100000	1.16E+05	4.18E-06	3.94E+04	3.94E+07
Chrysene	1.60E-03	398000	3.05E+03	3.88E-03	4.88E+00	4.88E+03
Dibenzo(a,h)anthracene	2.49E-03	3800000	2.91E+04	6.03E-07	7.26E+01	7.26E+04
Indeno(1,2,3-cd)pyrene	2.20E-05	3470000	2.66E+04	6.56E-05	5.86E-01	5.86E+02

Notes:

- 1 - Values calculated for soil saturation are dependent on soil moisture content and are subject to variability based on soil type.